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PROCEEDINGS OF THE SYMPOSIUM ON THE OCEANOGRAPHY AND FISHERIES RESOURCES OF THE TROPICAL ATLANTIC

RESULTS OF ICITA AND GTS

Organized through the joint efforts of UNESCO, FAO and OAU

Abidjan, 20 - 28 October 1966

REPORT AND ABSTRACTS OF PAPERS

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS - ROME, 1967

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REPORT AND ABSTRACTS OF PAPERS

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, September 1967

EDITORIAL NOTE

This volume is part of the Proceedings of the Symposium on the Oceanography and Fisheries Resources of the Tropical Atlantic (results of ICITA and GTS), organized through the joint efforts of UNESCO, FAO and OAU in October 1966, in Abidjan (Ivory Coast). The general Report and Abstracts of Scientific Papers presented at the Symposium are issued by FAO; the full texts of 37 of the 56 papers presented will be published by UNESCO, together with a complete author index and subject index.

ICITA - International Cooperative Investigations of the Tropical Atlantic
GTS - Guinean Trawling Survey

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I. INTRODUCTION

The Symposium was organized through the joint efforts of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Food and Agriculture Organization of the United Nations (FAO), and the Organization of African Unity (OAU), and held in Abidjan, Ivory Coast from 20-28 October 1966. The contributions of the co-sponsors towards the organization of the Symposium were as follows:-

UNESCO: legal agreement with the Government of the Ivory Coast for the holding of the Symposium; local arrangements; travel expenses and subsistence of certain invited participants; publication of volume of the Proceedings of the Symposium containing Review and Contributed Papers.

FAO: travel expenses and subsistence of certain invited participants; publication of volume of the Proceedings of the Symposium containing Report and Abstracts of Papers.

OAU: simultaneous interpretation; travel expenses and subsistence of certain invited participants; bilingual secretary.

In addition, the co-sponsors jointly participated in the preliminary planning of the Symposium and in the Symposium secretariat.

2. BACKGROUND

The International Cooperative Investigations of the Tropical Atlantic (ICITA) and the Guinean Trawling Survey (GTS) were an outcome of the original Commission for Technical Cooperation in Africa (CCTA) concept for a "Guinean Year". The historical background on these projects is given in the Introductory Lecture of Prof. Monod, delivered at the opening session of the Symposium.1/

The ICITA surveys were carried out under the auspices of the Intergovernmental Oceanographic Commission (IOC). An International Coordinating Group (ICG) was formed to coordinate the planning and activities of the ICITA, with Dr. T.S. Austin, originally Dr. V. Brook, as Chairman and International Coordinator. The ICITA oceanographic survey took place in three quasi-synoptic multiship operations:-

EQUALANT I	-	February/March 1963
EQUALANT II	-	August 1963
EQUALANT III	-	February/March 1964

The GTS took place under the auspices of the CCTA, later the Scientific, Technical and Research Commission of the Organization of African Unity, (OAU/STRC) with Dr. F. Williams as Director, and advised by a Scientific Committee (SC/GTS). The GTS, which studied the demersal fisheries resources and environment of the West African continental shelf between Senegal and the Congo, took place in two phases:-

GUINEAN I	-	September/December 1963
GUINEAN II	-	February/June 1964

Thus part of GUINEAN I was synoptic with EQUALANT II, and part of GUINEAN II with EQUALANT III.

FAO participated in the planning of both the ICITA and GTS, and also through UNDP/SF and TA projects in the West African area.

Prior to the completion of ICITA it was suggested by the ICG at its second meeting (Paris, July 1963 - Item 8), that a symposium should eventually be held to discuss the results of ICITA. The second session of the FAO Advisory Committee on Marine Resources Research (Rome, June 1964) recommended (ACMRR/2/Rec.19) that such a symposium should be held to discuss the results of ICITA and GTS and their implications on fisheries, and that it should be sponsored by FAO, UNESCO and OAU. Subsequently the second meeting of the SC/GTS (Lagos, April 1964 - Rec.10.1), and the Third Session of IOC (Paris,

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1/ see Annex 6

June 1964 - Res.III 4), endorsed the necessity for holding the symposium. The final draft proposals for the symposium were agreed by the Fourth Session of IOC (Paris, November 1965 - Annex X).

The detailed arrangements for the symposium were made by a Preparatory Committee consisting of one representative from UNESCO/IOC (Dr. G. Hempel), FAO (Dr. M. Ruivo) and OAU/STRC (Dr. E. Postel), and the International Coordinator for the ICITA and the Director GTS.

3. OPENING SESSION

Mr. A.O. Odelola, Executive Secretary, OAU/STRC introduced H.E. Mr. Alexis Thierry Lebbé, Minister of Animal Production, who in his opening address 1/ welcomed participants on behalf of the President, Government and people of the Ivory Coast.

The Minister stressed the importance of the sea in the development of the Ivory Coast. Exploration of the sea requires new fishing gear and methods, skilled personnel and above all common effort. The ocean belongs to everyone and fortunately it is one of the spheres particularly suitable for international cooperation.

In the nineteen fifties West African States realised the need to increase their efforts for exploration of the sea and the first symposium on the subject was organized by CCTA/CSA in 1957; at a subsequent meeting in Monrovia in 1960 the idea was developed for a series of oceanographic and fishing campaigns in the Gulf of Guinea.

The creation under the auspices of UNESCO of the Intergovernmental Oceanographic Commission gave an organization for world collaboration in oceanography, and of course, knowledge thus gained is of value to the development of fisheries. FAO has continued its efforts to assist the exploration and utilization of marine resources for the profit of African populations.

The Minister said that since the Ivory Coast started to study the sea in 1950, a Fisheries Department and an Oceanographic Research Centre had been established, the latter with considerable assistance from France. Their efforts would be valueless however, if they did not collaborate at an international level, as has been the case in the ICITA and GTS.

Congratulations were also due to the UNDP Special Fund for commencing investigations into shoaling pelagic fish, such as sardines, in the West African region, and which are very important to the Ivory Coast.

In conclusion the Minister remarked that the symposium marks a milestone in the history of marine sciences in West Africa. Following this exploration stage comes the period of exploitation of the resources, and for which the skills of all nationalities are required.

The Minister then declared open the symposium.

Further addresses 2/ of welcome were then made by Mr. A.O. Odelola representing the Secretary-General of OAU, Mr. B. Monsour representing the Director-General of UNESCO and Dr. M. Ruivo representing the Director-General of FAO.

An Introductory Lecture 3/ entitled "A Historical Review of the Marine Sciences in the Tropical Atlantic" was then delivered by Prof. Th. Monod.

1/ see Annex 2

2/ see Annexes 3, 4 and 5

3/ see Annex 6

4. OFFICERS AND ORGANIZATION OF WORK

4.1 Officers of the Symposium

Honorary President:	Prof. Th. Monod
Co-chairmen:	Dr. T.S. Austin Dr. F. Williams
Vice-chairmen:	Mr. J. Adjetey Mr. F.X. Paraiso

Rapporteurs:

Section 1 : Physical and Chemical Oceanography	Dr. G.R. Berrit
Section 2 : Productivity and Plankton	Dr. T.S. Austin
Section 3 : Pelagic Resources	Dr. M. Zei
Section 4 : Demersal Resources	Mr. S. Olsen

Scientific Secretariat:	Prof. G. Hempel Prof. E. Postel Dr. M. Ruivo

4.2 Organization of Work

The Symposium was arranged to cover the fields of, (1) Physical and Chemical Oceanography, (2) Productivity and Plankton, (3) Pelagic Resources, and (4) Demersal Resources. Twelve invited lecturers were asked to present Review Papers in the fields listed above (four in Section 1, four in Section 2, and two each in Sections 3 and 4). In addition, contributions were invited from participants in the ICITA and GTS, and other interested scientists working in the area, and these Contributed Papers totalled forty four. Following the work of these sections a discussion on the follow-up of ICITA and GTS was envisaged.1/ This discussion took place at a special session under the chairmanship of Mr. J. Adjetey and Mr. F. Paraiso and resulted in Resolution No.5.2/ A short prepared statement on the subject of ICITA/GTS follow-up was made by the USSR scientists present and is given in Annex 9.

All meetings of the Symposium were considered as plenary sessions.

5. SECTIONAL REPORTS

5.1 Physical and Chemical Oceanography

The two main topics dealt with in this section were: surface waters and the Equatorial undercurrent.

Hydrographic data on the surface waters of the tropical Atlantic are growing steadily, both for the open ocean, with the contributions of the EQUALANT campaigns, and for coastal waters, with the observations several laboratories have been making for many years, (13 years for the coastal station in Pointe-Noire). There are an increasing number of fixed stations and transects which are visited more or less regularly.

Several authors felt that available data is now adequate enough to enable them to suggest distribution patterns and variations of classic parameters for surface waters from 0 - 100 m depth over large areas. An examination of thermal structures associated with surface currents has shown the significant differences between the south Equatorial current and counter-current

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1/ see IOC 4th Session, Paris, November 1965 - Resolution IV/13

2/ see page

Particular attention has been given on both sides of the Atlantic to low salinity areas; their seasonal fluctuations in the Gulf of Guinea have been determined. An overall interpretation of the problem in this latter area was presented by one author which, based on the fresh water balance of coastal waters and surface currents, suggests the existence of circulation cells corresponding to the areas where waters of low salinity are found, - the Grain Coast, and Bay of Biafra - and with the regions of seasonal extension of guinean water, Senegal - Mauritania in the north, Angola in the south.

Studies of available data for the west african continental shelf confirm the proceding observations on seasonal fluctuations. Features of the hydro-climate are now well known for fishery purposes.

One paper dealt with an analyses of the thermal balance for the Equatorial zone and gave an evaluation of the heat flow across the discontinuity layer.

The presentation of temperature data by surface isotherms has attracted the attention of biologists. However, thermoclinal, isothermic and isohaline topographic charts seem more suitable for biological use than presentation by parameters for isobathic surfaces.

Studies on what happens to the water of the Congo River once it empties into the sea have made it possible to determine the zone of influence of the river at differant seasons of the year, and the report on this subject held the interest of the participants and elicited comment. Because of the variety and complexity of the subject of coastal waters little is known about them as yet. Along the coasts of tropical Africa and America, very low salinity environments are frequent and large, and it would be interesting to undertake a collation of the information gathered in these regions.

Little that is new came out of the reports on the dynamics of surface waters; some direct measurements using drift bottles were carried out off Brazil.

The mass of hydrographic data accumulated now enables us to approach the study of the dynamics of surface phenomena in certain regions.

Much has been learned in the last few years regarding the Equatorial undercurrent, and on which nine papers were presented. Work on this subject was conducted in 1963 and 1964, principally during EQUALANT I, II and III, by several independant research teams.

From the overall results presented, it appears that the undercurrent has been observed, measured and studied throughout its range from west to east.

All the authors were agreed on the zone between the parallels of 38° and $40^{\circ}W$ as the origin of the undercurrent and attribute it to two sources, one from the north and one from the south. Its longitudinal development depends on seasonal fluctuations, whilst its maximum extension seems to be at $6^{\circ}E$ and minimum between 0° and $5^{\circ}W$. In 1965, an expedition studied the variability of the undercurrent and showed short period fluctuations, a north-south oscillation of 75 miles and a vertical amplitude of about 10 meters.

Two main points particularly held the attention of the symposium and evoked discussion:

- the relationship between the high salinity core and the main body of the current. There was virtually unanimity on the finding that maximum velocity is not coincident with the salinity maximum.

- the variability of the extreme eastern limit of the undercurrent, which raises doubts as to the absolute value of the maximum salinity in the eastern part of the Gulf of Guinea and also on the origin of this maximum.

Several papers dealt with the theoretical aspects, the causes and mechanisms of this undercurrent. The problem was posed as to the role of the wind in the formation of the west-east zonal slope which is necessary for the development on this undercurrent.

A third group of papers relating to biological indicators, mainly Foraminifera, raised questions above all on the technology of the gear and methods used. According to the authors, it is principally biological research which can be examined from the standpoint of the physical use of these elements of the plankton. No general conclusions were reached on this subject.

Discussions in this section made it evident that the increase in the collaboration and cooperation between oceanographers and biologists, as recently shown in international activities in the Tropical Atlantic, should be continued. Certain west African coastal laboratories have now started identical or similar biological programs in different, though comparable environments. This approach to ecological problems will surely be effective, but only if the programs calling for physical observations are themselves of a similar nature, and if these laboratories maintain effective liaison. Similarly the discovery by oceanographers of analogous hydrographic features may help to bring biological studies being conducted in comparable regions in line with one another.

Discussions showed the necessity for increased collaboration in the oceanographic field, and the possible need for a regional centre that can compile and analyse data, of guaranteed accuracy and homogeneity, and then process the results in a directly usable form.

5.2 Productivity and Plankton

Prior to 1960, comparatively few investigations of primary productivity and measurements of standing crop of phytoplankton and zooplankton were made from research vessels in the tropical Atlantic. Essentially no synoptic, seasonal studies of large geographical areas were made prior to ICITA nor were there surveys with the sampling density of GTS. Each survey, in its unique way, provided opportunity for measurements of the rate of primary productivity, the biomass of phytoplankton and zooplankton and the relation of the seasonal and geographical fluctuations in each to variations in the physical-chemical environment of tropical Atlantic surface waters.

The most significant, and not unexpected, conclusion to be drawn from the ICITA and GTS review and contributed papers is that the variations in the measurements of the rate of primary productivity and the standing crops of phytoplankton and zooplankton may be related to the geographical and temporal fluctuations in the physical, chemical marine environment of the tropical Atlantic - particularly in the eastern area. In the "open waters" of the tropical oceans, the comparatively low standing crops of phytoplankton and zooplankton are related to the permanent thermocline and the attendant low concentrations of nutrients in the surface layer. Only in areas where vertical advection, or mixing processes, result in nutrient enrichment of the waters of the euphotic zone are there significant increases in the rates of primary productivity and in the standing crops of phytoplankton and zooplankton. The results from both the ICITA and the GTS measurements correlated nicely with the physical-chemical data -- an increased level in the rate of productivity and standing crops in the upwelling regions off Senegal, Ivory Coast and Ghana, in areas of river effluent, in the surface waters of the equatorial divergence and the northern boundary of the Equatorial Countercurrent. It is particularly interesting to note that, in those areas and seasons where indices of productivity were comparatively high, the standing crop of the fishes such as Sardinella was also reported as high.

To a major degree, equipment and sampling and analytical techniques were standardized for those samples and observations common to each participating vessel. Samples included were those for measurements of the rate of primary productivity (using the carbon 14 isotope in water samples collected at the sea surface and at depths with 50, 25, 10 and 1 percent of incident radiation, ICITA only), the distribution of microbiomass from albumen equivalents, seston (particulate matter plus plankton) and zooplankton standing crop (oblique 30 minute tows, surface to top of thermocline, with the ICITA, one meter diameter conical net). Temperature, salinity, dissolved oxygen and inorganic phosphate data are available (ICITA) for use with the results from each of the above measurements and samples.

The considerable efforts to standardize sampling and analytical techniques and intercalibrate instruments must be considered as "only partially successful". A considerably greater degree of standardization and intercalibration is necessary to separate experimental error from real, spatial and temporal fluctuations in the marine ecosystems.

It is not uncommon that more than one type of measurement is selected as an "index" to reflect the variations in rates of primary productivity, or standing crop. The ICITA/GTS data rather clearly demonstrated the dangers inherent in selecting a single type of measurement (in preference to the measurement of a spectrum) such as amounts of chlorophyll-a, albumen, seston, standing crops of biomass, rate of conversion of inorganic to organic carbon (C-14 isotope) or displacement volumes of zooplankton as an index to relative productivity. In some cases, data from a single type of measurement would have led to erroneous interpretation of the results when determining relative values for the specific index selected. An interesting analysis of energy transformation, insolation - phytoplankton - herbivores - carnivores, was reviewed. Again, the subsequent discussions reflected the uncertainties in such estimates, these uncertainties relating to somewhat imprecise definitions of herbivores and carnivores, to inadequate knowledge of the dominant species of each involved in the samples and to difficulties in precisely determining the percentage of total available flora and

fauna which were collected. In several cases, day/night variations were corrected for diurnal variations in incident radiation. The danger of too much confidence in such corrections, primarily because of the variations in the ecosystems sampled during ICITA and GTS, were discussed.

In addition to the need for increased efforts in standardization of sampling and analytical techniques and for intercalibration among such techniques, the need for data from monitoring stations in the eastern tropical Atlantic became increasingly evident. Both ICITA and GTS survey efforts were seasonally oriented, although results from the closely spaced network of GTS stations were better for the interpretation of seasonal and geographical changes. Answers to many of the questions raised during the discussions following the presentation of papers may only be resolved after analyses of data from longer periods of repeated sampling at fixed stations. Considering the evident relationships, particularly in West African waters, among the geographical and temporal variations in the physical, chemical and biological environment, and the fluctuations in the distribution and abundance of the commercially important fishes such as the Sardinella, the need for monitoring data in order to develop techniques to predict fluctuations in the distribution and abundance of the fishes, is strikingly evident. The participants in the Symposium unanimously agreed that the results of ICITA and GTS are adequate to permit judicious selection of the position for such stations to determine the program of observations and samples to be collected at each station.

5.3 Pelagic Resources

This section commenced with a review paper on the midwater fauna of the eastern tropical Atlantic, with special reference to the Gulf of Guinea. The paper was based on the results of work carried out by the r.v. JOHN ELLIOTT PILLSBURY between Cape Palmas and Anobon Island in May and June 1964 and 1965 using a 10 ft. Isaac-Kidd midwater trawl at depths down to 3,000 m. Counts were made of all specimens but unfortunately not volume due to the speed of disintegration of material. The IKMT results show that in the Gulf of Guinea the meso- and bathy-pelagic fauna approaches more closely the surface than in any other tropical regions. Certainly the midwater fauna is much richer in species and numbers than so far reported from the Atlantic. Comments were made on the possible exploitation of this midwater fauna.

The main review papers on pelagic fish dealt with (a) the sardines and related species of the eastern tropical Atlantic, and (b) the tunas of the whole tropical Atlantic. In addition, ten contributed papers were presented on these subjects. The review papers, as well as the contributed ones, provided a series of stimulating discussions amongst the participants of the symposium. The scientific reports and discussions stressed the great need for further collaboration by the exchange of personal views, experiences and scientific results amongst the marine scientists working on fisheries and biological problems along the Gulf of Guinea. The urgent need was for coordinated research work in this area, and certainly standardization of equipment and working methods would prove indispensible. Although the close relationship between the fish and environmental factors was pointed out in most of the papers, more collaboration is needed between the biologists and the physical/chemical oceanographers in order to overcome many gaps in our knowledge of the behaviour, distribution and exploration of marine pelagic resources.

The review of the life history of Sardinella and related species of the Gulf of Guinea placed emphasis on the three economically important species, i.e. Sardinella aurita, S. eba and Ethmalosa fimbriata (bonga). Special attention was paid to the knowledge gathered on these species since the World Scientific Meeting on the Biology of Sardines and Related Species, (Rome, 1959). Following points raised in the papers on sardinella and bonga, and in the discussions, some essential conclusions can be summarised.

Attempts should be made to distinguish intraspecific categories of sardinella using new biochemical methods. This might also help solve the taxonomic position of Sardinella cameronensis. While the geographical distribution does not present serious problems, except for two gaps off Nigeria/Gabon and Sierra Leone/Guinea, the depth distribution and abundance of the species are hardly known and present a problem of paramount importance to the fisheries. It was agreed that this problem should be tackled in many ways, amongst which acoustic surveys should have priority. The close relationship between the appearance and exploitation of sardines in inshore waters and the environmental factors (particularly temperature) was stressed; further detailed studies in this connection are highly desirable.

Very little is known of the differential distribution of sardinella or anchovies, although successful work for bonga was carried out in Sierra Leone waters. In future plankton studies, the eggs and larvae of Sardinella aurita and S. eba should be identified, and separated as to species; this problem has already been settled for anchovies and bonga. Coordinated surveys for the planktonic stages of sardinella and anchovies should be carried out on a large scale with standardized equipment. Special attention should be paid to the apparent dominance and abundance of anchovy eggs over those of sardinella in the plankton of the Gulf of Guinea. In this connection it should be pointed out that there is virtually no fishing for anchovies in this area.

Only one paper was devoted to bonga - on length and sex distribution, and catch effort in Nigeria.

Much data was presented on the bionomics and populations of Sardinella aurita in Ghana and the Ivory Coast. Age determination by scales proved satisfactory, and the first successful tagging of S. aurita was carried out in Ghana. Here again the value of coordinated work with neighbouring countries was stressed.

Chemical analysis of fat content in fresh S. aurita showed the relationship to the sexual cycle.

An evaluation was made of the sardine resources of Ghana, based on the catch statistics for canoes, and as an exercise designed to lead to an improved catch recording service for canoes.

In order to try to extend the sardine season for canoes, and to increase the catch of the purse seiners during the warm season, experimental light fishing was carried out with successful and promising results. In addition to those results, there are some other facts (trawling for sardines, close relation between temperature and abundance of sardines, fishermen observations, etc.), which suggest that large exploitable stocks of sardinella and anchovy must be present in deeper water, of rather low temperature, over most of the shelf of the Gulf of Guinea where no upwelling occurs. One might therefore, estimate roughly that the future landings of sardines in this part of the tropical Atlantic will be several times the present catch, which is thought to be at least half a million tons a year.

The review paper on tunas of the tropical Atlantic was mainly concerned with the distribution and abundance in time and space, of four species, blue fin (Thunnus thynnus), albacore (Germo alalunga), yellow fin (Neothunnus albacora) and big eye (Parathunnus obesus). Because of the great confusion of the tuna common names used in French and English, it was suggested (as detailed elsewnere by that author) that in both languages "Germo" should be used for Germo alalunga and "yellow fin" for Neothunnus albacora. The names "blue fin" and "big eye" do not cause any confusion.

Knowledge of the distribution and abundance of the above mentioned tunas in the tropical Atlantic is mainly due to the analysis of data supplied by commercial fisheries and to a lesser extent, to the observations made by oceanographic surveys. Consequently the area of distribution in space and time, as well as the abundance, were critically reviewed and many suggestions were made. The abundance data must certainly be biased because of the unreliability of the fisheries statistics giving sometimes double catch figures for the same landing. In this respect it was recommended that the FAO fish catch statistics section improve their checking of collected data. It was also pointed out that Japanese longline fishing data must be used with great care for the purpose of determining tuna distribution because of gear selectivity and other limitations, as well as rapid changes that have taken place in longline fishing and the abundance of tuna. Discussion revealed that whenever treating Japanese catch data for tuna, one should take note of the recent development of their fishing with regard to fish concentrations. Thus for instance, when yellow fin abundance decreased the Japanese tuna fleet shifted over to albacore populations and hence changed fishing grounds.

For abundance estimates one should use different gears separately. The catch per unit effort for longlines cannot be compared with that for purse seines. Thus, the ratio between the coastal surface yellow fin catches and the longline catches in deeper water was considered as unreliable. It was agreed that the methods for catching tuna are so varied that any assessment of the catch per unit effort will be inaccurate. An attempt was made to arrange the four tuna species in order of their abundance and was as follows:- yellow fin 40-45%, albacora 30-35%, blue fin and big eye 10-15%.

A detailed study of the catches of yellow fin along the eastern coasts of the south tropical Atlantic proved that the highest concentrations were in areas with strong thermic gradients. According to the data of EQUALANT I and II the larvae of yellow fin, big eye and skipjack, were widely distributed, whereas the larvae of albacore and blue fin were rather limited in their abundance. Temperature appeared to restrict the distribution of all the above mentioned tunas except skipjack. Salinity appeared to effect the distribution of larvae of yellow fin, but not of the other species.

Some attempts were made to find out the relations of tunas to their environment, especially in connection with the equatorial currents. Any conclusions on this subject seem rather premature to stand serious criticism.

5.4 Demersal Resources

The first contribution to this section of the symposium was a review of the results of the Guinean Trawling Survey.

The survey was carried out in two phases, the first from September to December 1963, and the second from February to June 1964, with two 35 m (600 h.p.) side trawlers using a 25 m. (head rope) trawl with 40 mm cod-end mesh size. Each phase covered the entire shelf area from southern Senegal to the Congo River in 63 transects at 8 different depths from 15/20 m. to 400/600 m. This vast area comprises five basic hydrographic zones, and the surveys were planned so as to yield observations from two different seasons in each zone.

The overall fish catch was dominated by one to nine species at anyone time or place, and these species formed from 45 to 98% by weight of the catch, but with considerable variations between areas, and from one depth interval to another within the same general area.

In many localities considerable contribution to the catch was made by pelagic species, such as Ilisha, Sardinella, Trachurus, and especially, Brachydeuterus auritus, which in most areas was always amongst the dominant species at depths less than 50 m. The next most important species at 15 to 50 m. was Galleoides decadactylus, Pseudotolithus senegalensis, Pagrus ehrenbergi and Ilisha africana. At 50 to 200 m. Paracubiceps was commonly dominant together with Trachurus, Priacanthus, Dentex angolensis and D. congoensis. On the continental slope, at 400 m. Paracubiceps was dominant from the Ivory Coast to Gabon, elsewhere at 400/600 m. Macrouridae and Hypoclydonia bella.

From the catch rates observed, which tended to vary considerably between the individual depth intervals, attempts were made to estimate average catch rates between 15 and 20 m. by statistical areas. The highest estimates were found in the Bissagos area, followed by the Congo area and the area off Guinea, whilst the lowest estimates were made for the areas off southern Liberia and Nigeria. The results thus confirm previous investigations showing that areas of highest fish abundance are those with seasonal hydrographic instability. The bathymetric distribution of total or demersal fish catches showed, with few exceptions, two distinct peaks of abundance, one above and one below the thermocline, corresponding to known fish community structures.

The estimates of average catch rates were used to calculate absolute density indices in terms of kg/hectare, and also the total standing crop for trawlable ground in each statistical area between depths of 15 and 200 m. The estimated total standing crop of demersal fish in the whole region between depths of 15 and 200 m. was one million metric tons. Because of the high density and large area, well over half of this amount was calculated for the Bissagos - Guinea shelf.

It was emphasised that with the data available this method of estimating standing crop is extremely crude, and is in this case likely to result in an underestimate of the available resources, the magnitude of the bias being entirely unassessable. Thus another contribution gave evidence of considerable variations in species composition when different types of trawls were used in the same locality and season. The standard gear used by GTS (and as pointed out in that report) cannot be assumed to have been equally efficient for all species of demersal fish, and in particular it was probably rather inefficient for catching flatfishes which, are taken with other types of trawl in considerable quantities along the coast. Consequently, it was concluded that a variety of gear has to be used to obtain reliable indices of abundance for different groups of fish.

However, in view of the time and means available for the GTS there can be no doubt that the survey was a great success which produced a vast amount of new knowledge about this region, and proved the existance of large fish resources which can and should be utilized. In particular the GTS showed that there are resources to support a commercial fishery on the Bissagos - Guinea shelf which is at present practically unexploited.

The second review paper in this section dealt with species assemblages of demersal fish. Prior to GTS data from various surveys showed that between Mauritania and Angola relatively uniform species assemblages of demersal fish were found on the continental shelf and upper slope under similar ecological conditions. Relatively few species appeared to be eurybathic.

It was possible to check these subjective analyses by use of the GTS results - comparable data from a very wide region. A computer program developed for the detection of recurrent species groups was used to analyse data on the 200 most frequently occurring species. This objective analysis confirmed to a high degree the previous suppositions and the assemblages were clearly outlined. These were also shown not to be as homogeneous as supposed, and within each assemblage a number of

subgroups were identified by the computer. The reality of these subgroups was confirmed by applying to them environmental data, which showed each subgroup had differing ecological requirements.

The geographical range of constituent species of assemblages which were those restricted to depths shallower than the thermocline do not extend north and south of the tropical region. However, the fauna of the deeper shelf below the thermocline, is very similar to that in similar or shallower depths in the regions of the subtropical eastern boundary currents. The upper continental slope fauna is virtually identical to that of similar depths off western Europe and also presumably far to the south.

The Gulf of Guinea is now the tropical region most completely explored for demersal fish resources. The species assemblages identified show very marked similarities with those identified in other tropical regions; tropical demersal fish resources generally appear to be similar in composition.

In order to assess the production potential of the fisheries resources of an area, it is also necessary to have basic knowledge of the life history of the various species, to which tropic levels they belong, their rate of reproduction, growth and mortality, etc. For some of the near water species and stocks which are presently being exploited, this research has for some time been carried out by national West African laboratories and other agencies. Some reports on this work were presented at the symposium, which demonstrated the difficulties encountered in this region with regard to stock identification, age, growth studies and sampling of the commercial catches, and also the progress made in solving these problems. Thus, for stock identification, work has been started in applying methods of bio-chemical analysis by means of electrophoresis and the introduction of the "burnt otolith" technique has facilitated age determination of fish which were previously considered nearly impossible to age.

Contributions also dealt with the research and exploratory work carried out on the prawn resources in Nigerian waters. The available evidence suggested that there are resources in this area to support a substantial commercial prawn fishery, which is presently developing at a fast rate. The knowledge of the magnitude, distribution and dynamics of these resources is still rather fragmentary, and in view of the potential commercial importance of this fishery, intensified research work in this field is highly desirable.

6. RESOLUTIONS

RESOLUTION No.1

RECOGNISING the success of the Symposium, particularly in relation to the development and exchange of knowledge concerning oceanography and of the present and potential fisheries resources in the Gulf of Guinea, and
REALISING the prominent role of the Government of the Ivory Coast, the host country, in providing facilities for the holding of the Symposium,
THE PARTICIPANTS, individually and collectively, as well as the representatives of UNESCO, FAO and OAU/STRC,
EXPRESS their appreciation to the President, the Ministers of Animal Production and External Affairs and to the People of the Republic of Ivory Coast, for the fine demonstration of international cooperation and hospitality.

RESOLUTION No.2

RECOGNISING the high scientific standards of the review and contributed papers and
REALISING the significance for fostering marine science and for resources utilization in the area, as reflected by the extensive discussions by participants in the Symposium,
IT IS RECOMMENDED that the Proceedings of the Symposium should be published as soon as possible by UNESCO and FAO and made available to the Governments and marine scientists of Western Africa, to the scientific international community interested in the area, and to the international organizations concerned, for the best use of the findings and appropriate follow-up of ICITA and GTS in terms of scientific and fisheries development programs.

RESOLUTION No.3

RECOGNISING that the Symposium demonstrated once again the value of joint action by U.N. Special Agencies in the field of marine science and its applications, and

NOTING the value of the exchange of results and ideas among scientists and technicians of all disciplines for the development of oceanography and fisheries research, the participants commend UNESCO, FAO and OAU/STRC for their successful cooperation which brings great benefits to science and to member countries, and they
RECOMMEND that UNESCO and FAO, in cooperation with regional organizations, continue and strengthen their collaboration in arranging regional symposia which bring together marine scientists and fisheries experts. Similar collaboration should be encouraged in other fields of common interest.

RESOLUTION No.4

REALISING the need for regional cooperative environmental and marine resources studies, including surveys, monitoring activities and frequent and extensive exchange of data and research results amongst nations of the region, and further
RECOGNISING the potential value of these activities and increasing number of projects under UNDP executed by FAO and bilateral and marine fisheries programs for fostering those results and
RECOGNISING the role of international cooperative programs as exemplified by ICITA and GTS in generating and fostering those results,
IT IS RECOMMENDED that cooperative activities carried out jointly by UNESCO, FAO and regional organizations be continued and, in Africa, that close collaboration be maintained with OAU/STRC.

RESOLUTION No.5

NOTING the request in the Resolution IOC IV/13 that the Secretary of IOC should seek to convene a Working Group in conjunction with the Symposium on Oceanography and Fisheries Resources of the Tropical Atlantic in order to ensure the application of ICITA and GTS to research and fisheries development in West African areas and to develop cooperative research programs in the area,
REVIEWING the scientific results of the Symposium, and
RECOGNISING the generally high quality of marine research activities in the West African region, most of which were directly related to ICITA and GTS or to subsequent follow-up of these international activities by FAO/UNDP projects and by national institutions, and
RECOGNISING the attempts towards the development of cooperative marine and fisheries survey and research programs in West Africa;
RECOGNISING that the creation of a formal Intergovernmental Working Group is not the most appropriate machinery for the follow-up of ICITA and GTS;
RECOGNISING, however, the importance of oceanographic research in itself and in providing background for fisheries research in the West African region,
IT IS RECOMMENDED that UNESCO/IOC and FAO continue and augment cooperative activities in the region and implement these activities in part by:

(a) training of scientists and technicians in oceanographic and fisheries techniques, including measurements on board ships and at monitoring stations, collection and analysis of samples, data processing and analysis, including quality control;

(b) assisting the procurement of instruments for vessels and inshore based laboratories;

(c) providing for consultants, as requested by West African member states for follow-up activities related to ICITA and GTS and for the planning and development of cooperative programs in oceanography and resources research;

(d) encouraging and assisting, when appropriate, standardisation and intercalibration in the fields of oceanography, marine biology and fisheries research;

(e) encouraging and assisting in the establishment of a West African Regional Oceanographic Data Centre as a link between national activities and World Data Centers A and B to complement the services provided for resources data by the FAO Fishery Data Centre (Rome). In this respect it invites the attention of the IOC to the activities in compiling data from various stations in the region by the Centre de Recherches Oceanographiques, Abidjan, Republic of Ivory Coast.

7. CLOSING SESSION

Mr. F.X. Paraiso (representing Mr. A.O. Odelola, Executive Secretary, OAU/STRC), Prof. G. Hempel (UNESCO), Dr. M. Ruivo (FAO), Prof. E. Postel (OAU/STRC), emphasised the value of the Symposium and expressed their satisfaction at the excellent results of this joint action. The Co-chairmen, Dr. T.S. Austin and Dr. F. Williams, were gratified to see this Symposium as a product of the activities, ICITA and GTS, for which they had been responsible.

The importance the Government of the Ivory Coast attached to the role of science and technology in economic development was stressed by the attendance of H.E. Mr. Alexis Thierry Lebbé, Minister of Animal Production, at the closing session. In a brief address the Minister congratulated participants and sponsoring organizations for the excellent manner in which the Symposium had been conducted.

The meeting was then ADJOURNED

ANNEX I

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ANNEX 2

OPENING ADDRESS *

by

His Excellency Mr. Alexis Thierry Lebbé
Minister of Animal Production
IVORY COAST

I must first thank all the distinguished persons here present who, despite their numerous occupations, have accepted the invitation to attend this inaugural session of the Symposium on Oceanography and Fisheries Resources of the Tropical Atlantic. By so doing, gentlemen, you are demonstrating your great interest in matters relating to the seas so vital to the economic development of our nations.

Gentlemen, it is both an honour and a great joy for me, representing the Ivory Coast, to bid welcome to men of science attending this Symposium which has set itself the task of summing up the work in the field of oceanography in the Tropical Atlantic in recent years.

On behalf of my Government and its President, HOUPHOUET-BOIGNY, and in the name of the people of the Ivory Coast, I welcome you to our capital.

The Ivory Coast owes much to the seas. Our port is a window on the world. Our expanding economy brings us into contact with the most distant lands whose ships dock at our quays. Our neighbours also receive and export some of their merchandise through this port, which cements our common ties.

With the opening of the Vridi Canal deep sea fishing off our coast was started and has since expanded. The number of boats, trawlers and sardine fishing vessels has risen from 14 to 72 in the decade 1955-65, and landings have increased from 5,000 to 45,000 tons.

Our Government, fully aware of the significance of the fishing industry in our economic development and in the feeding of our people, has spared no effort to build up port facilities to cope with new requirements. Private industry has shared in this expansion and has already installed refrigeration plant and canneries.

The ocean is indeed vital to the life of our country and we feel that every means should be used to learn more about it.

The children in our schools learn with astonishment that the seas cover two-thirds of the area of the globe and yet, until only a very short time ago, all we knew of these seas was what could be seen on the surface. Whereas mankind has already started on a conquest of space, we are strangely ignorant of much that pertains to our oceans. Man expects to land on the moon in the very near future, yet has just reached the point of being able to penetrate to the great depths of the seas on his own planet. We are, indeed, working to make the dream of Jules VERNE, that imaginative writer about life under the seas, come true. Our bathyscaphes and submarines have started to explore this practically unknown world, but so enormous are the seven seas that the means hitherto utilized appear insignificant in comparison.

We must find new methods, novel devices and, above all, train more scientists and technicians - and it is here that our shortcomings, I was going to say, weaknesses, are most evident! whence the need for concerted efforts and pooling of ideas.

The ocean belongs to all. Beyond the territorial waters which each country claims in order to safeguard its own security, all may ply the seas freely. This is the realm par excellence for international collaboration - collaboration which was born simultaneously with

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* Original in French

oceanography, the subject with which we are concerned. It has created associations such as the International Council for the Exploration of the Sea (ICES); the General Fisheries Council for the Mediterranean and the Inter-American Tropical Tuna Commission, to mention only three of the best known and longest in existence, chosen at random.

It was towards 1954 that Africa in its turn became conscious of the need to organize its efforts and explore its seas. Men of science on the Scientific Council for Africa and its executive body, the Commission for Technical Co-operation in Africa (CCTA), met at Luanda in 1957 at the first congress on maritime problems in Africa and decided to organize a permanent setup for such coordination. The CCTA, which was later amalgamated with the Scientific, Technical and Research Commission of the Organization of African Unity (OAU), launched the idea of an oceanographic survey in the Gulf of Guinea (Monrovia, 1960).

Ideas are born when they are ready and this project aroused much interest among governments which have supported it effectively. It led to two operations the results of which you will now, in the next nine days, examine - the Guinean Trawling Survey and the three Equalant expeditions.

The setting up of the Intergovernmental Oceanographic Commission (IOC) by UNESCO broadened collaboration in the field of oceanography to a worldwide scale. It naturally formed the background for the creation of a working party on special problems of tropical and equatorial waters. As advances in knowledge occur, applications therefor are found and the development of fisheries follows progress in oceanography. The FAO, whose work merits our recognition, has also made every effort to promote and encourage every type of action that can lead to better utilization of marine resources for the benefit of the peoples of Africa.

The Ivory Coast, with a great effort and with the help of its friends, is now slowly emerging from its backwardness, and despite its still very limited means, plans to participate actively in the joint work.

Oceanographic research is already an established tradition with us, some of our physicists and biologists having begun studies on the sea as far back as 1950. Since then we have set up a fisheries service concerned with the fishing industry and fisheries laws, and an oceanographic centre. This year we have decided, with the collaboration of France, to triple the staff of research workers of this centre and enlarge its terms of reference.

Our efforts would be incomplete or truly insignificant if they are not part of a larger whole. In fact, only through international collaboration can we advance in our knowledge of the ocean and its laws.

The Ivory Coast associates itself with, and will in the future continue to participate in, this great drive towards mutual comprehension and liaison which has prevailed over partisan views, rivalries, political and economic conflicts to enable a dozen countries to carry out operations such as the EQUALANT campaigns and the Guinean Trawling Survey.

We applaud the United Nations Special Fund for its promotion of a broad range of studies of coastal pelagic fish on the continental shelf of Africa. This project, will, we hope, bring immense, as yet underexploited resources within the reach of our peoples. The Ivory Coast will take an active part in these studies. This regional project has already been approved and work will be started on it next year.

The meeting at Abidjan of oceanographers, physicists and biologists working on the inter-tropical Atlantic is a landmark in the history of oceanography.

Our part of the world has had the benefit of only a very few, rapid scientific expeditions. Indeed, there is a striking contrast between the total number of hydrological stations in the South Atlantic - 8,000 - and the 120,000 in the North Atlantic. Discoveries are increasing apace and advancing into the less known regions. Within the past 15 years our seas, once practically deserted or on which only a few pirogues ventured out, have seen the apperance of trawlers, sardine fishing vessels, tuna clippers and factory ships.

The wealth offered by the ocean must henceforth be wisely managed to derive incalculable returns while preserving the stocks of fish, which are our "capital", avoiding over exploitation

of these resources to the detriment of future generations.

Following a period of prospection and discovery, we have reached the stage of applying scientific principles to fishing. More than ever before, however, there is now necessary a mutual accord among men of all nationalities and all trades interested in the seas and its resources.

For these reasons I am happy, not only to greet you but to express our deep satisfaction in seeing international collaboration being organized for this part of the tropical Atlantic.

Gentlemen, I wish you a pleasurable stay in our capital and a successful conference, the results of which we will await, and I hereby declare open the Symposium on the Oceanography and Fisheries Resources of the Tropical Atlantic.

ANNEX 3

ADDRESS

by

Mr. A.O. Odelola,
Executive Secretary
Scientific, Technical and Research Commission
Organization of African Unity
LAGOS

Honourable Minister, Distinguished Delegates:

I bring you the sincere good wishes of the Administrative Secretary General of the O.A.U., Mr. Diallo Telli, for a successful meeting. I should like to thank H.E. the President, the Government and the People of Ivory Coast for their hospitality and for the excellent facilities placed at the disposal of this meeting.

The practical problem of development of the ocean resources surrounding the Continent of Africa is of supreme importance to the O.A.U. I should like to remind you, Mr. Minister, and distinguished Delegates, that to the north, Africa is bounded by the Mediterranean Sea, to the east by the Indian Ocean, to the south by the Pacific Ocean and to the west by the Atlantic Ocean. Up to now other nations from other continents compete in the exploitation of the resources of these oceans to the benefit of their own nationals. I must admit that they sell a part of their catch off our coasts at prohibitive prices to us and this acts as a drain on our foreign exchange. Anyone who suspects this remark should help himself to the Trade Statistics of a few important O.A.U. States and the facts will stare him in the face. Hitherto there has been very limited activity on the part of African States in the exploitation of the ocean resources, largely because of three important factors.

In the first place we are ignorant of the resources which are available in the oceans around us. This should not surprise anyone. By and large we are still ignorant of what is possible on land and even what is known to be of value is being utilized on a rather limited scale or not utilized at all. Secondly, we lack the skill to tap these resources and finally we have little or no money to invest in the development and exploitation of these resources.

I do not intend, Mr. Minister and distinguished Delegates, to bore you with an analysis of the obvious. It can, however, bear repetition to remind ourselves that because of the urgent need to find solutions to the combination of these human, technical and economic factors affecting their economic development, African States have come together under the Addis Ababa Charter of the O.A.U. It is certainly easier to solve problems when we all face them together on a united front. This is not to say that there will be no headaches thereby: it does mean, however, that the problems will have a common platform for their solution on the principle of give and take. Secondly, the O.A.U. has indicated its faith in the United Nations and the United Nations Special Agencies by participating actively in all their activities and by encouraging active co-operation and joint action at all levels - a concrete example is the joint nature of this Symposium.

Mr. Minister and distinguished Delegates, papers submitted for discussion at this Symposium cover various aspects of research activity as it concerns the Atlantic Ocean. The O.A.U. favours systematic research and planned exploitation of the resources of the Tropical Atlantic. This is particularly important as all African States bordering the Atlantic are at present under-developed and have rather limited direct hand in these activities at present. The Guinean Trawling Survey is the first regional (and concerted) action by all the States in the field of Fisheries aimed at, among other things, an inventory of the bottom fish potential of the West African continental shelf. We acknowledge with sincere thanks the financial contributions of the U.S.A.I.D. and the technical assistance from many others on the survey. The survey is an attempt on our part to solve a part of the frustrating and embarrassing problem of ignorance of the available resources. I am happy that as far as the Eastern Atlantic is concerned other surveys have either been completed or are in progress. When all these are completed, our

knowledge of the potentialities of the ocean shall certainly be improved. It is our hope that the need for planned and concerted action will be noted by all concerned so as to ensure a regular flow of protein not only to Africa but to the rest of the world.

Furthermore, the O.A.U. will expect that subsequent pre-investment surveys which will be undertaken for particular Governments or groups of Governments on the west coast will make it possible for these O.A.U. States to develop and expand their fisheries for the twin objectives of providing additional protein for their peoples and opening up of dependable additional sources of foreign exchange through the Fish Trade. It must be emphasized, however, that to know what is available is not enough to-day. We must be able to exploit it.

This leads us to the second problem, that of skill. Getting enough African Scientists to participate in this Symposium has been an intractable exercise for some of us closely connected with the preparatory work. I must admit that the standard of the discussion expected places a premium on the quality of the participants. However, the problem of dearth of qualified African personnel is a real problem. This is not an item for discussion at this Symposium, but I crave your indulgence, Mr. Minister, and distinguished Delegates for referring to the urgent need for training of personnel at both the research level and the middle grade level in Africa. I was at the F.A.O. recently and I was happy to find some evidence of the awareness of these problems. I would ask, too, that the two United Nations agencies sponsoring this Symposium with us should note this fact seriously that there is need for training programmes in both inland and ocean fisheries in Africa. We are grateful for the research being done off our coast, but enough is enough. We do not want to be a mere laboratory for other continents. Research and survey should be geared to the exploitation of the resources by our Governments and the training of our own people to do the job at all levels.

It may be useful to add, at this juncture, that the O.A.U. is a very suitable and the most appropriate organization for joint regional training and research schemes in Africa. We were instrumental in the setting up of the College for Wildlife Management in East Africa and we are at present discussing the setting up of two regional plant protection and crop protection centres, one in Abidjan for French-speaking States and another in an English-speaking location for English-speaking States. The Guinean Trawling Survey was a regional pre-investment survey, at present we have a regional animal health project in progress which is worth over 10 million U.S. dollars in foreign aid and almost half as much again in counterpart contributions. All African States in the Savannah belt of Africa from Mauritania on the West Coast to Tanzania on the East are participating in this animal health project. I hope these examples will bring the point home that African States are aware of the limited resources within each sovereign State and are therefore prepared to co-operate to solve their development problems.

Mr. Minister, African States are not rich enough to finance all their development efforts by themselves. This should surprise no one. There is no evidence in history of any advanced country that has attained material welfare and a high standard of living for its peoples through its own resources alone. History tells us that development activity has always been conducted on the basis of mutual inter-dependence of the nations of the world. Capital and know-how flew both ways across the Atlantic in the 19th and early 20th centuries for the development of North America and Europe: even reconstruction work after the second world war was done on an international mutual assistance basis through the Marshall Plan. Development of Africa will certainly not be an exception to this rule. Thus, while African States believe firmly in self-help, they appreciate the need for additional external funds for their development activities. In this regard, the improvement of research activities for both ocean and inland fisheries in Africa will require additional financial and technical assistance. Aid will also be required for the development and exploitation of the resources of the various States to take advantage of the result of pre-investment surveys. It is a well-known fact that there is a shortage of protein in the under-developed world. We should, however, remember that fisheries will contribute to additional protein in Africa only if additional funds are available to African States for the exploitation of resources of the oceans and inland lakes and rivers.

ANNEX 4

ADDRESS *

by

Mr. Bernard Monsour
Chief, UNESCO Mission to the Ivory Coast

Your Excellency, Excellencies, Ladies and Gentlemen,

It is my first duty to express the regrets of Mr. René Maheu, Director-General of UNESCO, for being unable to attend this Symposium this morning, as he would have liked, because of the importance he attaches to such an international meeting of scientists - the first such meeting organized in Africa - for research and its applications. He is detained in preparation for the 14th Session of the General Conference of UNESCO which is opening in a few days. However, Dr. Hempel of UNESCO's Office of Oceanography will be able to transmit to the Director-General his report on this Symposium immediately after you have completed your work.

For many years now the tropical Atlantic has been explored by national expeditions, like those of the CHALLENGER, and ATLANTIS and the METEOR. Much invaluable information was gathered by such expeditions, contributing to a fuller knowledge of the tropical Atlantic and its biological resources. However, only by means of a co-ordinated campaign conducted by several ships simultaneously can such enormous resources be fully explored. A study by this appropriate method was suggested in 1960, for the first time and could become operational following the creation by UNESCO of the Intergovernmental Oceanographic Commission (IOC). It became possible to arrange for the immediate exchange of the information gathered so that this work has now reached the final phase, that of preparation of an oceanographic atlas for the tropical Atlantic.

In order that this vast scientific enterprise might be conducted properly the IOC set up a coordinating body which played a major role in the organization of the necessary international collaboration. UNESCO's Oceanography Office performs the secretarial functions for the IOC on a regular basis.

Such international cooperation in research work in the tropical Atlantic was not conceived as an academic exercise but as the instrument of more thorough study of the tropical Atlantic for the benefit of mankind. The oceanographical and biological research done on this expedition laid the foundations for the establishment of new fisheries.

We owe acknowledgement, to Messrs. Vernon Brock and Austin for their enthusiasm and energetic participation, but their efforts would have been vain if not backed by the devoted labour of many scientists, technicians and the members of the crews of the oceanographic vessels engaged in these campaigns.

The Guinean Trawling Survey sponsored by the Organization of African Unity (OAU) under the direction of Dr. Williams, and another joint survey recently conducted in this region went far beyond the immediate requirements of fisheries in the Gulf of Guinea. UNESCO has been following this campaign with special interest and its aid has been enlisted in analysis of landings. A discussion on the findings of both the International Cooperative Investigations of the Tropical Atlantic (ICITA) and the Guinean Trawling Survey (GTS) later on in this Symposium should impart a better understanding of the principles underlying the fisheries activities in the tropics.

At this Symposium you will go beyond mere examination of the findings of the two said campaigns to determine what prospects there are for oceanographic research in the tropical Atlantic with the emerging countries participating as they wish in concerted action. UNESCO will fully support such activities whenever this is deemed necessary and to the fullest extent possible. I merely wish to say how happy the Director-General of UNESCO is about the cooperation here launched between the OAU, FAO and UNESCO. OAU and FAO have made contributions of the utmost significance, and I wish to convey UNESCO's appreciation to the representatives

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* Original in French

of these two great international bodies. Permit me also to render special homage to the Scientific, Technical and Research Commission of the OAU and its executive secretary, Mr. Odelola, who made the arrangements for this Symposium. I would also like to thank and extend greetings to Prof. Theodore Monod and the eminent scientists here assembled at the call of these three international agencies.

In closing may I ask you, your Excellency, to transmit to his Excellency, the President of the Republic of the Ivory Coast, the gratitude of the Director-General of UNESCO for the hospitality extended to this Symposium. The existence at Abidjan of a world renowned oceanographic research centre was an attraction for the experts here convened. This is the fourth international meeting in which UNESCO is participating this year. Your country's welcome has always been extremely generous and cordial, and demonstrates your Republic's support for international action. On behalf of Mr. René Maheu, Director-General of UNESCO, therefore, may I wish this Symposium every success.

ANNEX 5

ADDRESS *

by

Dr. M. Ruivo
Chief, Marine Biology and Environment Branch,
Fishery Resources and Exploitation Division
FAO
ROME

Mr. Minister, Your Excellencies, Ladies and Gentlemen,

May I first of all thank the Minister for his kind words and say, on behalf of the Director-General of FAO, how much the help and the facilities accorded the organisers of this symposium by the Government of the Republic of the Ivory Coast have been appreciated.

It is a great honour for me to represent FAO on this occasion and on behalf of the Organization to welcome all participants to this symposium. As Secretary to the FAO Advisory Committee on Marine Resources Research (ACMRR), I have a further ground for satisfaction - which, I am sure is shared by those members of that Committee in this hall to-day - in that the recommendation we put forward in 1964 to the effect that UNESCO, the Organization of African Unity (OAU) and FAO jointly organise a symposium on the results of the International Cooperative Investigations of the Tropical Atlantic (ICITA) and the Guinean Trawling Survey (GTS) and their implications for fisheries (a recommendation which was enlarged and endorsed by the Intergovernmental Oceanographic Commission (IOC)), should have been instrumental in bringing together such an important gathering of experts from all the countries that supported and participated in the expeditions.

I should like to congratulate the OAU and UNESCO/IOC for their efficient handling of the projects in which FAO too, has collaborated in every way possible through its technical assistance experts working in West Africa.

May I stress how FAO has consistently encouraged all activities in the field of marine science, since in furthering of our understanding of marine organisms and the environment is of interest to fishery science and the rational utilisation of the resources of the sea. Accordingly, FAO is most anxious to strengthen cooperation with other international organisations engaged in activities complementary to its own in this field, in particular with UNESCO and, in the case of Africa, with the Scientific, Technical and Research Commission (STRC) of OAU.

As we see it, the pooling of the experts services and facilities of these organizations is the most effective way of promoting a coordinated development of science and of fisheries. The recent reorganisation of FAO's activities in this domain, to be seen in the establishment of a permanent Committee on Fisheries (COFI), and the raising of the former Fisheries Division to the rank of Department, will make for an expansion in technical assistance to member nations and better servicing of the activities of our regional bodies. This strengthening of FAO's operational potential will in its turn make for international collaboration on an even larger scale.

As the Director-General of FAO made clear at the first session of the Committee on Fisheries, the world is deeply concerned for its food resources, the next twenty years will be highly critical should the very rapid growth in world population not be accompanied by a corresponding expansion in food production, particularly of high quality protein, which is where the greatest need lies. At the present time fish is an example of food that is being produced at a much faster rate than that at which the human population is growing. These generalisations are equally true of Africa; the seas off this continent abound in fish, but despite the efforts of the African countries themselves and the technical assistance, both

* Original in French

bilateral and international, that they have received, a major part of these resources either goes unexploited or the fishery products do not reach the great mass of consumers.

The detection, evaluation and conservation of marine resources, the intensification of experimental fishing, the selection and adaptation of catching methods, and the preparation and training of personnel at all levels are so many essential elements in the development of African countries, even assuming that investment problems are solved. FAO is well aware of the difficulties and, to the extent that its means permit, will endeavour to tackle these problems as both part of its activities under Regular Program and of those in the field conducted under Technical Assistance and Special Fund of the U.N. Development Program.

I have just listened, with great interest, to the very apposite comments of the Executive Secretary of the Scientific and Technical Research Commission of OAU. I am glad to be able to confirm that FAO is doing its utmost to implement an expanded training program. A FAO mission is currently visiting the French-speaking countries of Africa in order to ascertain needs and to decide on the measures to be taken and the means required in order to organise accelerated training of the specialised personnel required for fisheries development and, again, in order to offer guide lines for our technical assistance planning. This mission follows on a similar one, conducted last year - the report has just been published - to the English-speaking countries of Africa. A training centre on fishermen's training for English-speaking countries in Africa with developing fisheries, will begin in Freetown, Sierra Leone on 1st November this year.

Again, it is gratifying to note that the projects for resources surveys for Sardinella and other clupeoid fishes in West Africa (Gulf of Guinea) - plans for which were developed by ACMRR - has enabled FAO to initiate an important network of national fisheries development projects, and also a regional one, financed by the UNDP Special Fund with FAO as Executing Agency. Under the projects in question - they concern Senegal, Sierra Leone, Ivory Coast and Congo (Brazzaville), in addition to those in progress in Ghana and Nigeria, a very large number of experts are at work - I am pleased to see many of them present in this hall - and proper research craft and equipment have been allocated. It is the intention to conduct an intensive series of surveys for the purpose of locating and evaluating the abundance of stocks of edible species. For this, acoustic methods will be used, under a plan developed by an ACMRR Working Party. For the project to be successful it is necessary that equipment and working methods should be standardised, statistics improved and there should be a regular exchange of information and experts, not to mention effective coordination of the many national and international organisations taking part.

For all this, changes in organisational structure must be made and FAO has accordingly taken the necessary steps to reorganise its regional activities, hitherto the responsibility of the Regional Fisheries Commission for Western Africa, with secretariat at the FAO Regional Office at Accra. Unfortunately, as you are aware, the Commission has encountered a number of difficulties, though we have reason to believe they will soon be overcome. Thus, pursuant to a recommendation of the 13th Session of the FAO Conference, preparatory work is going forward with a view to convening in April/May 1967, a conference of fisheries officers of West African countries at which this important question will be discussed. The Conference will have the benefit of the findings of this symposium.

Accelerated economic development, as one of the main objectives pursued by governments, demands a clear definition of priorities and an increasing application of science and technology for the rational utilisation of natural resources, and it is with this in mind that FAO has envisaged the present symposium. I am sure that its success will be the finest reward for the many experts who have been associated over recent years with ICITA and GTS and those who have been working in many African countries under technical assistance arrangements.

I have spoken rather longer than I had intended and I must ask your indulgence for making such demands on your patience, but I am anxious to take this opportunity to indicate to you the spirit in which FAO carries on its work in the region.

Before I conclude allow me to reiterate how gratifying it is for us to work in close collaboration with UNESCO, OAU and member countries.

These are the considerations which it is my wish to put before you on behalf of FAO, together with the Organization's wishes for the greater success in your deliberations. Once again, allow me to tender to the President of the Republic of the Ivory Coast, to the Government, and to you, Mr. Minister, the thanks of the Director-General of FAO for the very effective help which has permitted the holding of this symposium.

ANNEX 6

INTRODUCTORY LECTURE

A Historical Review of the Marine Sciences in the Tropical Atlantic *

by

Prof. Th. Monod,
Membre de l'Académie des Sciences
Muséum National d'Histoire Naturelle,
PARIS

It will not be my purpose to-day, of course, to summarise our knowledge of the oceanography or the fauna of the Gulf of Guinea - this would not only be beyond my competence but would be in danger of being out of date and superseded, during the days ahead of us, by your own various contributions.

Taking, therefore, a less ambitious approach, I have considered that it would be of more use to give you, as a preface or, if you wish, a backcloth to your work, a historical outline of exploration in the Gulf of Guinea, in relation to your own special subjects. For a zoologist who landed on the west coast of Africa for the first time 44 years ago this has been an opportunity to retrace briefly the development of the marine sciences in this part of the world, from their more humble and difficult beginnings to their present-day successes and considerable resources.

Naturally, we shall be dealing only with the Gulf of Guinea, within the arbitrary limits of 17°W and 10°S, including Ascension Island but excluding St. Helena - broadly, therefore, the west coast, from Cape Roxo to Luanda and the area bounded by the lines perpendicular to these two points.

It is certainly true that, for various reasons, the Gulf of Guinea has until recently been fairly neglected and has remained to some extent a kind of backwater as far as oceanographic research was concerned. In particular, coastal laboratories were set up there much later than in many other tropical regions and it is unfortunately the case that there are still very few African research workers there.

1. Geographical background and the Dark Ocean (before 1450)

Africa does not remain unaffected by the law of climatic and biological dissymmetry which affects southern continents: the zone of warm water, which is of considerable extent on the east coast, 1/ is much narrower on the west 2/ and there are no real coral reefs in the west where Pinnipeds occur from 21°N 3/ and from about 16°S. But the west coast of Africa, the Atlantic side of the continent, contrasts with the other (eastern one, towards India) by reason, generally, of its geographical position and the consequences resulting from this.

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* Original in French

1/ Approximately 50° between the surface isotherms of 25°C.
2/ Here: only 22°.
3/ A specimen of Monachus monachus has even been observed in Senegal.

While the temperate and intertropical Atlantic seems, during the course of human history to have represented a major gap, which will only be bridged in recent times, 1/ it will be seen that the east coast was known, already by the Ancient World, perhaps as far as 20°S (Sofala). The west coast, on the other hand, seems scarcely to have been known beyond southern Morocco. It was doubtless thought that Hanno had reached the Cameroons and that Ptolemy's findings extended as far as 10°N 2/ - not to mention the very questionable voyage of Nechao. The most recent conclusions incline, however, more and more to caution: 3/ the Dark Ocean of Africa, unknown to the Ancient World, was not explored until the 15th century by European sailors, although it is thought that, in the Middle Ages, there may have been some rather debatable voyages prior to 1434. 4/ These did not, however, include the Gulf of Guinea at all.

11. From the Descobrimento to the abolition of the Slave Trade (1450-1850)

Once the Descobrimento had begun, with the passage of Cape Bojador (1434), we see that very quickly, within some 50 years, the entire west coast of Africa was explored: 5/ Cape Verde was reached in 1444, Sierra Leone about 1460, what was to be Ghana (S. Jorge da Mina) in 1471, the Cameroons or Rio dos Camaraos (Shrimp River) about 1471-75, the Congo in 1484 (Diogo Cão), the Cape in 1488 (Bartholomew Dias). The Gulf of Guinea had taken its place in history. 6/

Although there were, as yet, no oceanographers, there were, for centuries, sailors there - at first, Portugese, then English, French, Dutch and Danish. Methods of navigation were improved and a mass of observations made on winds, currents etc. Interesting observations occur in the "Portugese Pilot", 7/ in the journal of ALVARO VELHO, 8/ in the important work of FONTOURA DA COSTA, "A marinharia dos descobrimentos", 9/ where it is stated (page 352) that ALEIXO DA MOTA (about 1621) observed the Current of Guinea and the Southern Equatorial Current. Several 17th century works already contain interesting details of the Gulf of Guinea: B. VARENIUS in his Geographia generalis (1650) speaks of temperature, salinity, currents, winds, 10/ etc. We know of the famous "Tabula geographico-hydrographica motus oceani, currentes..." of P ATHANASIUS KIRCHER (Mundus subterraneus, 1,1678) with the currents of the tropical Atlantic; E. HALLEY in 1688, published a wind map for the same area, which was remarkable for the period.11/

1/ Cf TH.MONOD. Au bord de l'Océan Ténébreux: Atlantique et Afrique, Sénégal, Saint-Louis,III 1944, p.65, 188 and 202, 23 fig. and La Terre est-elle ronde ? Informations UNESCO, No.371, 13 Jan.61, p.7-9,figs.

2/ Cf.e.g. G. SCHOTT, Geographie des Atlantischen Ozeans, 1942.pl.1.

3/ Cf. R. MAUNY, Note on the voyage of Hanno, 1st Internat.Conf. on West Africa, Dakar 1945, II, 1951, p.509-530, 4 maps, 1 fig. G. GERMAIN, Qu'est-ce que le périple d'Hannon ?Document, amplification ou faux intégral, Hesperis, 3rd-4th term 1957,p. 205-248, and R. MAUNY, L'Ouest africain chez Ptolémée (approx. 141 A.D.) Internat. Conf. Afric. de l'Ouest, Bissau 1947, Lisbon, 1950, I, p.239-293, 1 map.

4/ Cf. R. MAUNY, Navigations médiévales sur les côtes sahariennes antérieures à la découverte portugaise (1434) Centro Est. Hist. Ultram., Lisbon, 1960, 151 p., 5 fig.

5/ And given a wide range of Portugese place names, which are listed in A. TEIXEIRA DA MOTA, Topominos de origem portuguesa na costa ocidental de Africa desde o Cabo Bojador ao Cabo de Santa Catarina, Centr. Est. Guiné Port, No.14, Bissau, 1950, 411 p., 7 maps.

6/ As an introduction to the history of the discovery the following may be consulted: COSTA BROCHADO, The discovery of the Atlantic, Lisbon, 1960, 127 p., 4 maps, and DAMIÃO PERES, A history of the Portugese discoveries, Lisbon, 1960, 129 p.; useful references will be found in the Bibliographia henriquina, Lisbon, 1960, 2 vol., XI+325 and 383 p.

7/ G. SAUVAGEOT, Navigation de Lisbonne à l'île São Tomé par un Pilote portugais anonyme (about 1545), annotated by Th.Monod and R.Mauny, Garcia de Orta (Lisbon), 9, No.1, 1961, p.123-138, X pl.

8/ ALVARO VELHO, Roteiro da primeira viagem de Vasco da Gama (1497-99) ed. A. FONTOURA DA COSTA, 2ªed., Lisbon, 1960 XXII + 236 p., 12 fig.

9/ Lisbon, 3ªed., 1940, 532 p., XXXII picts., 143 fig., 8 col.pl (ubi litt).

10/ The equatorial calms in the Gulf of Guinea are mentioned on p.437 of edition 4ª, Jena, 1663

11/ An Historical Account of the Trade winds, and Monsoons, observable in the Seas between and near the Tropicks, with an attempt to assign the phisical cause of the said Winds, Phil. Trans., London, XVI, Num.183, for July-Aug.-Sept. 1687, publ. 1688, p.153-168, 1 map. See also: J.G. KOHL, Aeltere Geschichte der Atlantischen Strömungen, Zeitschr.allg.Erdkunde, Berlin, N.F., XI 1861, pp. 305-341 and 385-446, pl. IV (chiefly concerns the Gulf Stream).

While knowledge of direct use to sailors increased with the growth of trade, that relating to the natural sciences made much slower progress. For centuries it remained, as for example in Europe, at the stage of the exotic object of curiosity e.g. the "Rariteit Kamer" and the "Cabinet", the saw of the Saw-Fish (Pristis), the shell of the tortoise, the stuffed Porcupine Fishes, or the Cypraea. It must not, however, be forgotten that accounts of voyages contain, from the beginning, notes on fishes and various marine animals. Later, pictures of them appear, e.g. in various compilations such as the amazing account by BARBOT (1732): A Description of the Coasts of North and South Guinea and of Ethiopia inferior vulgarly Angola.

Marine zoology in the real sense seems to have established itself in relation to the Gulf of Guinea with the voyage to the Congo of J. CRANCH, who in 1816 accompanied Captain J.K. TUCKEY to the Congo, where he died. Cranch's journal in manuscript is (why or how it came there is not known) in the Paris Museum. 1/ It contains a series of drawings of marine animals e.g. 2 Leptocephali taken at 4°29' and 4°38'N, a tunny parasitic worm,etc.

It seems to me that this voyage of March-June 1816 can be considered to be the first oceanographic expedition in the Gulf of Guinea. Not only are many examples of the fauna of the open sea described and sometimes illustrated (crustacean larvae, etc.) but there are details of current measurements, water temperature, an instance of red water, floating islands (the botanist, Dr. Smith, attempts to identify certain constituents of these). Several dredging operations took place off the coast of Gabon: "The dredge was put over board, and brought up two or three species of echini, and some small cancri, bits of coral etc." writes Tuckey for instance (Narrative . , 1818, p53). Finally, this voyage is doubtless the one associated with the first mention of the abundance of tunny in the Gulf of Guinea. 2/ Arriving at Gabon Tuckey notes (ibidem, p.52): "the albicores which had accompanied us in vast shoals to the edge of soundings, and were taken in such numbers, that besides being consumed fresh to satiety, the crews of both vessels pickled and salted several barrels, now entirely disappeared . ." Here, then, in 1816, we have the tunny being caught and cured in the Gulf of Guinea - a fact worthy of note.

III. Marine Sciences (since 1850)

a) Hydrographers and navigators

Hydrography, of course, continued to make progress and various national authorities concerned published ever more accurate documents, marine maps, on the one hand, manuals for the navigator, on the other, of the "Nautical instructions" type: African Pilot, Segelhandbuch, etc.)

Finally, thanks to the cooperation of commercial vessels who were accumulating observations in a systematic manner, it became possible to publish works embracing these observations and giving in map form a considerable amount of data on the air and the surface waters. The following works of this type can be listed:

1) Atlas des Atlantischen Ozeans, Deutsche Seewarte, 2nd ed., 1902
2) KLUIT, Observations océanographiques et météorologiques dans la région du courant de Guinée (1885-1900), Kon.Ned. Meteor.Inst., No.95, Utrecht, 1904, 116 p. and atlas, VIII pl.
3) Oceanographische en Meteorologische Waarnemingen (i.e. observations) in den Atlantischen Ozean, March-April-May (1856-1920), 24 maps - June-July-August (1870-1922), 24 maps - Sept.-Oct.-Nov. (1870-1925), 24 maps - Dec.-Jan.-Feb. (1870-1914), 26 maps, Kon.Ned. Meteor.Inst., No.110, 1921-1931.
4) Remarks to accompany the monthly charts of meteorological data for the nine 10° squares of the Atlantic which lie between 20°N and 10°S Lat., and extend from 10° to 40°W Long. ending with the best routes across the Equator, Meteor. Committee, Off. Number 27, H.M. Stat. Off., London, 1876, 568 p.
5) A.SCHUMACHER, Ann.d.Hydrogr., Berlin, 1940, p.109: current charts.

1/ It is my intention to publish it.
2/ What Cranch calls "albicore" is evidently Neothunnus albacora.

6 - 7) Although of a different nature, and incorporating already a number of recent oceanographic data, the following can also be cited here:

- F.C. FUGLISTER, Atlantic Ocean Atlas of temperature and salinity profiles ..., Woods Hole, 1960

- Provisional oceanographic charts of the tropical Atlantic Ocean, ICITA National Oceanographic Data Center, Washington, May 1962, 71 p., 48 figs.

b) Naturalist travellers

For two centuries (for Michel Adanson seems to have been from 1749 to 1754 the first representative in tropical Africa of a long line of naturalist travellers, whose lives and working conditions are very difficult for their modern successors to imagine), we owe the growth of our knowledge of the fauna of the Gulf of Guinea to naturalists travellers.

Some of these collectors, thanks to whom the marine fauna of the coasts of the Gulf of Guinea (practically unknown before) began slowly and painfully to emerge from obscurity, have remained anonymous. For many others only a name is known to us, deciphered from a museum tag. The majority were amateurs, doctors, civil servants, officers, missionaries, sailors, etc. If one name deserves mention here, it is that of CARL HUPFER (1841-1894) who, from 1886 to 1891, commanded a vessel of the Woerman Company and made extensive collections in the Gulf of Guinea, on which were based the famous Beiträge zur Kenntnis der Meeresfauna Westafrikas (1914-1925). Captain J. VON EITZEN also made a collection, in 1912 to 1913, of sea fishes off the Cameroons, which has been studied by EHRENBAUM.

Along with the amateurs several professional zoologists emerge. They can, however, until the post-war eruption, be counted on the fingers of one hand. There were freelances, at whose achievements one is amazed when one considers their miserable resources. We can name RICHARD GREEFF, who succeeded CLAUS at Marburg and then LEYDIG at Tübingen, and who explored the coasts of São Tomé in 1879-1880; CH. GRAVIER (1865-1937), professor at the Paris Museum, who visited the same island in 1906; and A. GRUVEL (1870-1941), also a professor at the Museum, who worked mainly along the coasts of Mauretania and Senegal, but also along those of the Gulf of Guinea (1909-1910); the biologist and ichythyologist LUDWIG KEILHACK, who arrived in the Cameroons in 1914 and was killed during the war. I myself was, to a certain extent, continuing his tradition in 1925-1926.

c) The major expeditions (up to 1960)

Local amateurs and travellers on expeditions clearly saw themselves limited, by lack of resources, to shore work. A new chapter in the exploration of the Gulf of Guinea opened with the appearance in these waters of special survey vessels. Some of these only passed through the region incidentally, while circumnavigating the globe (e.g. "Valdivia"); others included the Gulf of Guinea in a major Atlantic programme (e.g. "Meteor"); yet others made the tropical Eastern Atlantic the main object of their voyages (e.g. "Buccaneer", "Möwe", "Atlantide"). One can also distinguish the "oceanographic" expeditions from those directed more especially towards the resources and techniques of fishing.

With regard to the Gulf of Guinea, I found it impossible to make fine distinctions and, without claiming that it is at all complete, I will give a list of the expeditions, as follows:

- "Challenger" (U.K., 1876) - touches at Ascension '1876, St. 343-344): Report on the Scientific Results . . 1873-76, 1/ 50 vol., London, 1880-1895, 29492 p., 3008 pl.38, col. pl. 236 maps.
- "Gazelle" (German, 1874) - Die Forschungsreise S.M.S. "Gazelle" . . 1874-1876, Berlin 1888-1890, 5 vol.
- "Buccaneer" (U.K., 1886) - Gulf of Guinea: J.Y. BUCHANAN, The exploration of the Gulf of Guinea, Scottish Geogr.Mag., IV, 1888, p.177-200, VIII illus. and 235-251, 4 fig. (1 pl.h. t.) and V illus. This is the first oceanographic expedition in the Gulf (by a cable-layer of 700 t., belonging to the Indian Rubber, Gutta Percha, and Telegraph Works Company Ltd.); Doctor BUCHANAN was accompanied by the zoologist JOHN RATTRAY

1/ Actually, "Challenger" left England in December 1872.

- "National" (German, 1889) - touches at Ascension: Ergebn. Plankton-Exped. Humboldt-Stiftung, Kiel und Leipzig, 5 vol., 1892-1913.
- "Valdivia" (German, 1898) - Wiss.Ergebn.Dtsch.Tiefsee-Exped. "Valdivia" (1898-1899), 23 vol., 1902-1927
- "Gauss" (German, 1901-03) - touches at Ascension (1901,1903): German South Pole Exped. 1901-1903, 20 vol., 2 atlas, Berlin, 1908-1931
- "Planet" (German, 1906) - Die Forschungsreise S.M.S. "Planet", Berlin, Reichsmarineamt, 5 vol., 1909
- "Möwe" (German, 1911) - G. SCHOTT, B. SCHULZ, P. PERLEWITZ, Die Forschungsreise S.M.S. "Möwe" in Jahre 1911, Archiv.Dtsch.Seewart, Hamburg, 37, 1914, Nr.1.
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- "Johann Hjort" (Norwegian, 1959) - Gulf of Guinea.

This list is certainly very incomplete, either because some voyages from coastal laboratories might, in view of their extent, have merited inclusion or because no details are known of certain American, Japanese or Russian oceanographic operations related to fishing (chiefly of the Clupeidae of coastal waters or the tunny of the open sea).

d) Establishment in situ

While the many global voyages so famous in the 18th and 19th centuries were replaced by specialised or regional voyages, progress in research in the Gulf of Guinea was, towards the end of the second World War, most effectively speeded up by the appearance of a new factor, the coastal laboratory. Hitherto, vessels and travellers, having come from some distant port or museum, only passed through the area and, after several quick operations, returned with their booty of collections, samples of water and measurements to their departure point. Sooner or later the necessity was bound to be felt for setting up permanent bases on the spot, in direct and continuous contact with the environment being studied. A ground station became an essential requirement.

Below are listed, by country, the organisations and services involved:

- Guinea, Conakry: Office des Pêches maritimes.
- Sierra Leone, Freetown: a) Marine Station, University College, Fourah Bay - b) Division of Fisheries, Ministry of Natural Resources.

- Liberia, Monrovia: a) Division of Science, University of Liberia - b) Bureau of Fisheries.
- Ivory Coast, Abidjan: a) Centre de Recherches Océanographiques - b) Service des Pêches Maritimes, Ministère de la Production animale.
- Ghana: a) Fishery Research Unit FAO-GHANA, UNSF Project, Accra - b) Fisheries Inspectorate Unit, Ministry of Agriculture: Osu Fisheries Station.
- Dahomey, Cotonou: Service des Pêches.
- Nigeria, Lagos: Federal Fisheries Service.
- Congo-Brazzaville, Pointe-Noire: Centre d'Océanographie et des Pêches.

The recent advances in our knowledge can be attributed largely to the development, during the last 25 years, of local research. The list of shore and neritic fauna is constantly being added to and in places the marine fauna is already as well known, as far as the main groups are concerned, as that in many European areas. A great deal of oceanographic data, relating to lithology and hydrology, has been accumulated, which can already be collated to a certain degree. Let me refer here, for instance, to three works which are indispensable, in this connection, to the research worker: those of Dr. Alan R. LONGHURST, An ecological survey of the West African marine Benthos (Col.Off., Fish.Publ.No.11, 1958, 102 p., 11 figs.) and A review of the Oceanography of the Gulf of Guinea, Bull.Inst.Fr.Afr.Noire, XXIV, sér. A, no.3, 1962, p.633-663, 9 fig., and that of Dr. E.POSTEL, Biologie marine et biologie appliquée à l'industrie des pêches, p.385-406 in Enquête sur les ressources naturelles du continent africain UNESCO, 1963. Each year now sees the addition of a number of new publications to those devoted to oceanographical research in the Gulf of Guinea.

e) International cooperation

While frontiers on land between various countries are often arbitrary, the marine environment remains, basically, a unity, which does not lend itself to political division. Hence, it represents an ideal area for collaboration between various countries: firstly, at the intra-African level, between adjacent shore territories, and, secondly, at the global level, for, in particular, oceanographical studies in the open sea and also for coastal research based on specific programmes (dredging/trawling, Clupeidae, etc).

The Scientific Council for Africa (CSA) (1950) and the Commission for Technical Cooperation in Africa (CCTA) (1945), the latter of which became in 1965 the Scientific, Technical and Research Commission (STRC) of the Organisation of African Unity (OAU), have shared a common secretariat since 1954 and have naturally been directly concerned with problems of oceanography and sea fisheries off the coasts of Africa. This is shown by the nomination, in 1959, of Dr. E. POSTEL as inter-African Coordinator for Oceanography, Marine Biology and Sea Fisheries and by the organisation of several scientific conferences, some of which were fairly directly concerned with the Gulf of Guinea, e.g. Symposium on Oceanography and Sea Fisheries off the West Coast of Africa (Luanda, 20-27 Nov.1957); conference of CSA specialists on the coordination of research into sea fisheries off the West Coast of Africa (Monrovia, 5-10 Dec.1960); Symposium on the tunny group (Dakar,12-17 Dec.1960); conference of CSA specialists on Crustacea (Zanzibar, 19-26 April 1964). These conferences have resulted in numerous papers, which have not been edited but only distributed as typed copies, apart from the ones from Zanzibar - these have been collected into a volume, which is being printed at the moment, in the series Mémoires de l'I.F.A.N.

Another useful publication is the Bulletin de Liaison des Laboratoires (OAU/STRC) edited by Dr. POSTEL (6 numbers have appeared, 1960-1965).

I may add that the International Council for the Exploration of the Sea is officially extending its terms of reference to the Equator and that the F.A.O., which is awaiting the formation of an African Fisheries Council, has had a permanent representative in Accra since 1960.

To return to the Monrovia conference, it will be seen that this meeting took account of several recent developments at international level in the Gulf of Guinea.

It was actually on this occasion that Dr. POSTEL presented a paper entitled "Project for an international survey in the Gulf of Guinea"; this was an extremely ambitious project, comprising:

1. A scientific survey in the open sea, extending over the entire Gulf of Guinea (12°N-16°S and 17°W-14°E) and following a geometrical plot of routes covering 20,000 miles.

2. Three experimental fishery surveys:
   a) dredging/trawling on the Bissagos shelf

b) fishes of the tunny group
c) " " " sardine group

In agreeing in principle to the project as a whole, the conference pronounced in favour of the following order of priorities: a dredging/trawling survey "from Mauretania to Angola" - an oceanographic survey - a sardine-sum-tunny operation. The project was defined in a conference held in Lagos in August 1961, was approved by the C.S.A. and then by the C.C.T.A., under the designation "Année Guinéenne" (Guinean Year) (Joint Project No.19), and was given a Scientific Committee over which I had the honour to preside. 1/ From 1961 onwards it was to enter upon an active preparatory stage. Considerable problems arose, of a financial, technical (vessels) and scientific (personnel) nature. Let it be stated immediately that the U.S. International Co-operation Agency (ICA) (which has since become the U.S. Agency for International Development (USAID)) undertook to finance the organisation of the Guinean Trawling Survey (GTS), the only aspect of the initial project which had remained under the direct responsibility of the CCTA/CSA. Its implementation was mainly due to the tireless activity of Dr. POSTEL, just as the survey itself and the utilisation of the data obtained would not have met with the success which is universally acknowledged had it not been for the firm and competent direction of our friend Frank WILLIAMS.

Actually, the programme had to be revised somewhat for, when Dr. POSTEL and I arrived at the Bureau of Commercial Fisheries in 1961, we learned that the latter had its own expeditionary project in the Gulf of Guinea, mainly directed, incidentally, at oceanographic work in the open sea and tunny fishing.

This project soon assumed ever larger proportions and, during a conference which I attended in June 1962 in Washington, a programme was prepared for international oceanographic research, not only in the Gulf of Guinea but in the tropical Atlantic. This was designated International Co-operative Investigations of the Tropical Atlantic (ICITA), and was adopted in September 1962 by the Inter-governmental Oceanographic Commission (IOC) of UNESCO.

The course of the four parts of the initial project can be followed separately from then on. It should not, however, be forgotten that various new ideas added at intervals were incorporated quite naturally, even though they sometimes involved considerable prolonging or extension of the programme as outlined since 1960.

The four main categories of international cooperation, since 1962, are as follows:

1. The "Guinean Trawling Survey" (GTS).
2. The "International Co-operative Investigations of the Tropical Atlantic (ICITA).
3. The experimental tunny fishing survey.
4. The "sardine" project in course of preparation.

Considerable details will be supplied, on subsequent days, of these various aspects of oceanographic research in the Gulf of Guinea.

My part as chronicler of marine research in this region now ceases and I shall hand over to other speakers who, on subsequent days, will give details of results achieved during recent years. They will also indicate the stage we have reached in knowledge of a marine field which, after being all too long neglected, is at present under extremely active study, both in relation to commercial fishing (observations derived from which are seldom published) and to oceanographic research (the results of which are systematically published). In fact, although international collaboration between scientists does not present any special difficulties, it must be admitted that a considerable body of data exists, which has been assembled by commercial fishing vessels and is difficult of access for the research worker and may even be unknown to him. This is a situation with which we are well acquainted in another field, that of earth sciences, where official geologists can have only a partial knowledge of the results obtained by their colleagues in the oil sphere. In my opinion, this point deserves to be borne in mind.

1/ And which was to meet at Dakar in March 1963, at Lagos in April 1964 and in Paris in June 1965.

Finally, I can only congratulate myself on having witnessed - in my lifetime and since my arrival on the west coast of Africa in 1922, almost half a century ago - such substantial additions to our knowledge of the marine fauna and oceanography of the Gulf of Guinea. Doubtless a great deal is still to be done, of course, in all fields, even as regards making a simple catalogue of the fauna of certain groups. But to-day, thanks to the efforts of recent years, we have at least a firm basis for future expansion of research. The happy results of international cooperation, both inter-African (OAU/STRC) and general, can only encourage one to hope that it will continue and even, possibly, be intensified.

ANNEX 7

AUTHOR INDEX AND TITLES OF PAPERS

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Bayagbona, E.O.	Sampling and Computational Procedures for Estimating the Size Distribution of Croaker Species landed by trawlers in Lagos, Nigeria.	C	En.	4	
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ANNEX 8

ABSTRACTS OF PAPERS PRESENTED AT THE SYMPOSIUM ON THE OCEANOGRAPHY AND FISHERIES RESOURCES OF THE TROPICAL ATLANTIC
(Results of ICITA and GTS)

No.1 On an Improvement concerning the Numbering of Marsden Statistical Squares

by

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Centre de Recherches Océanographiques, ABIDJAN

We propose a change in numbering of the Marsden statistical squares in which the figures utilized for numbering the squares are the right ones expressing their geographical coordinates.

All the advantages of the Marsden system are maintained including the case of utilization in oceanography.

No.2 Age Determination and the Bertalanffy Growth Parameters of Two Croaker Species - Pseudotolithus typus and P. senegalensis using the Burnt Otolith Technique

by

Edward O. Bayagbona
Federal Fisheries Service, LAGOS

The classical methods of age determination by observing the hyaline and opaque zones in scales, otoliths and bones have been applied to tropical fish by various workers. When applied to the two croaker species considered in this paper, the technique was not satisfactory, and so other methods had to be investigated. The Peterson method, using length frequency distributions, was tried out, but because of the long spawning season of the species there are numerous broods in each year class, and it becomes impossible to distinguish between year classes after the fish have been in the fishery for over 18 months. This is further made difficult by the fact that the bulk of the fish caught, with the present Nigerian fishing practice, are 18 months old and by the time the fish is three years old, it is hardly represented in the catch. The technique used in the work reported in this paper is therefore a significant break-through in this field of study.

The otolith, which is quite massive in size, is ground down on a fine electric grinding stone, along a longitudinal axis. The exposed surface is then laid down flat on a wire gauze and heated until the surface goes brown in colour. On cooling it is examined under a binocular microscope with the surface kept wet with clove oil. Alternating white and dark zones could be clearly observed.

The white and dark zones are correlated with high and low conditions of the fish which are further correlated with low and high breeding activities. It is therefore concluded that during the first year of life (i.e. the rest of the spawning season of its origin and the non spawning season after that) a white zone forming the nucleus is laid down. At the next spawning season

a dark zone is laid down followed by a white zone during the succeeding non-spawning season, and so on. The spawning season is from February to June of the same year, and the young fish originating from that season will themselves spawn during the next spawning season. Fish having an origin late in the spawning season do not spawn much in the next spawning season. (This confirms the findings of Longhurst 1964). As a result only a faint thin first dark zone is laid down. But during the next spawning season the fish spawns heavily twice as indicated by two prominent dark zones separated by a thin white zone.

In practice, the average length of fish in a given age group throughout a growth year can be determined more accurately than the length at a particular date. Samples were therefore collected all through the year and placed in groups 0 t_o1, 1 to 2 years old etc. A mean length was then found for each age group and used to determine the Bertalanffy growth parameters: for P.typus L^{∞}103 cm, K = 0.29 and t_o = - 0.15 year, for P. senegalensis L^{∞}81 K = 0.33 and t_o = 0. From these, it has been possible to work out a theoretical length-at-age table from which a theoretical growth curve was constructed for either of the species.

No.3 **Haemoglobin Agar Electrophoresis in Pseudotolithus typus and P. senegalensis from the Nigerian Coast**

by

Edward O. Bayagbona
Federal Fisheries Service, LAGOS

The aim is to demonstrate haemoglobin polymorphism in either of the species and to investigate whether the proportion of each type of haemoglobin varies in samples collected from various regions along the Nigerian coast. The experiments were carried out using a phosphate buffer of pH 7.3 and ionic strength 0.02, freshly prepared oxyhaemoglobin solutions, sodium citrate as anticoagulant and 0.6 gms of purified agar in 100 mls. of buffer as the electrophoretic medium.

The haemoglobins were run at about 8°C for one hour at 200 V between platinum electrodes. Patterns obtained were very sharp and clear but were constant for either species so that polymorphism was not demonstrated.

No.4 **Sampling and Computational Procedures for Estimating the Size Distribution of Croaker Species Landed by Trawlers in Lagos, Nigeria**

by

Edward O. Bayagbona
Federal Fisheries Service, LAGOS

The following are the problems involved:

1. There is no fishing terminal; so each boat-owner uses his own privately arranged landing jetty. These jetties are in different localities, and with the Fishery Department's limited available staff, it is not possible to post persons on each jetty to record fish landings. So the fishing boat owners send monthly records of their catch to the department.

2. The croaker catch is made up of at least two similar species, but the fishermen do not separate the species. They are landed and recorded as croakers. In Lagos, for most of the year, the croaker catch of trawlers is made up to two species only, and so the procedures outlined here are on the assumption that the croakers are made up of only two species. During other months of the year when more species contribute to the croaker catch, suitable adjustments

have to be made to break up the catch into its constituent species.

3. The very small sized croakers are mixed up with other thrash fish in the same boxes and recorded as miscellaneous.

Sampling for size distribution takes place twice a week, and the computational procedures are a monthly exercise aimed at extracting the small croaker component from the record of miscellaneous fish landings and then breaking up each of the category of croakers landed into their constituent species.

No.5 On the Annual Variations of Temperature and Salinity in the Shelf Waters off North-west Africa and on the Date Limits of the Fisheries Season

by

R.G. Bernikov
Atlantic Research Institute of Fisheries and Oceanography
KALININGRAD

The author analysed all available historical data on physical and meteorological characteristics of the Tropical Atlantic and all the analogous data collected by the Atlantic Branch of the Oceanographic and Fisheries Research Institute for the period 1957-1965 and identified hydrological periods. The author found these periods coinciding very well with those established earlier by Berrit.

No.6 Preliminary Results of Research Work under the ICITA Plan by the Atlantic Research Institute of Fisheries and Oceanography

by

R.G. Bernikov et al
Atlantic Research Institute of Fisheries and Oceanography
KALININGRAD

The paper summarises biological results of observations along the meridians 50°W and 10°W during various seasons of 1963-1965. These observations were carried out by r/v ZVEZDA. Productive zones were identified on the basis of plankton biomass analysis. It was found that these productive zones change their position from season to season. Changes also occur there in plankton composition.

No.7 Low Salinity Waters of the Gulf of Guinea *

by

G.R. Berrit
Centre de Recherches Océanographiques, ABIDJAN

The rains in the equatorial zone, the freshwater run-off and the weak evaporation rate maintain permanently in the Gulf of Guinea masses of low salinity water, the vertical and

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* Review Paper

and horizontal extension of which varies considerably around the year.

There are two main areas of formation of these waters, the Bight of Biafra and the Grain Coast. Another notable zone of permanent low salinity water is due to the Congo River discharge.

The Bight of Biafra is the most characteristic and the best known of the low salinity zones. A descriptive seasonal diagram of its hydrology can be given. The freshwater balance indicates that the fresh water run-off is compensated by evaporation, and the existing excess corresponds to the rains at sea. The surface currents seem to form a clockwise-gyro based on the island of Principe.

The region of the Grain Coast is not as well known. The decrease in salinity is less, due to the smaller run-off from the land. Compared with the Bight of Biafra it is always found linked to a seasonal extension zone, to the north in the boreal summer and to the east in the austral summer.

The available data, permits the probable hypothesis of a dynamic "dome" off the Liberian and Guinean coasts.

From September to May, low salinity water spreads southwards to St. Paul de Loanda in a coastal band of about 300 miles. It may be fed, at least partially, by an outflow from the Bight of Biafra transported by a southbound current, the existence of which is assumed from dynamic calculations. Between the Equator and Mossamedes there are probably one or more dynamic "domes".

The northward extension zone of low salinity waters, similar to that off Angola, also covers the coastal area reaching the parallel of Nouakchott during the boreal summer. The freshwater balance inclines one to interpret the seasonal salinity decrease as the effect of a flow of water from the south, which is confirmed by current measurements.

During the austral warm season low salinity water also spreads to the coasts of Dahomey, Ghana and the Ivory Coast. The run-off from the Grain Coast does not seem to play an essential part in lowering of salinities which could be attributed to local rainfall.

No.8 Distribution of Foraminifera as Indicators of Water Masses in the Western Part of the Tropical Atlantic *

by

Esteban Boltovskoy
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The living planktonic Foraminifera gathered in the upper 300 m (300-0 m) in the western part of the Equatorial Atlantic, in February-April, 1963, were studied.

In total 16 species - all typical of low latitudes - were determined in the upper 100 m layer. From these species: a) the following were found frequently or even abundantly: Globigerina dutertrei, Globigerinella aequilateralis, Globigerinita glutinata, Globigerinoides conglobatus, G. ruber, G. "elongatus", G. trilobus (f. typica), Globorotalia menardii (f. typica), Orbulina universa. b) The following species quantitatively were relatively rare: Globigerina rubescens, Globigerinita cf. humilis, Globigerinoides trilobus, (f. sacculifera), Globorotalia menardii (f. tumida), Hastigerina pelagica, Pulleniatina obliquiloculata, Candeina nitida.

Globigerina bulloides, G. sp "A", Globorotalia crassaformis, G. hirsuta, and G. scitula were found only in depths greater than 200 m and as very rare, isolated specimens.

The vertical quantitative distribution of living specimens is as follows (surface abundance is taken as 100%): surface - 100%; 25 m - 134%; 40 m - 274%; 50 m - 121%; 80 m - 23%;

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100 m - 24%; 200 m - 12%; 300 m - 5%. The denser population in a depth of 40 m could be explained by the better conditions of nourishment, as many representatives of phytoplankton, especially coccolithophorids, are known to be more numerous at about this level.

Daily vertical migrations of Foraminifera could not be found in the area studied.

Analysis of horizontal distribution of Foraminifera in the upper 100 m of water showed that the whole area could be divided rather distinctly into two zones: a) North-northwestern and b) South-southeastern. The limit between them passes along the latitude 4°N, moving south, between longitude 37° and 40°W, approximately to latitude 1°N. Then, westward from longitude 45°W, it runs more or less parallel to and at some distance from the coastline of South America

The former zone has typical open-sea fauna. The south-southeastern zone differs in the complete lack of Globigerinoides conglobatus, G. trilobus (f. sacculifera), Candeina nitida and Pulleniatina obliquiloculata. In addition its fauna is markedly less abundant and somewhat undersizedand looks like typical fauna of coastal waters of the Guiana current, although it occupies a much larger area than does that current according to physical oceanographers.

It is not possible to relate the above division with any physical or chemical water properties known in the area under study. We should accept that this biological separation was caused by some factors still unknown.

No.9 Eastward Tropical Currents off Northern Brazil

by

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During EQUALANT I and EQUALANT II, the Argentine Navy and Texas A and M made cruises off northeastern Brazil. To supplement these cruises, Texas A and M undertook an expedition off northern Brazil in summer 1964. Physical oceanographic results are discussed.

The first eastward current to enter the region observed appeared at about 8°N, 50°W. This current, called here the East-southeast (ESE) Current, was characterized by a high salinity core at mid-thermocline and set east-southeast between 50°W and 45°W, forming the northern limb of a strong anticyclonic eddy centred at 3°N, 46.5°W, off the mouths of the Amazon. The Guiana Current which formed the southern limb of the eddy contributed some water to the ESE Current at the eddy. Between 45°W and 40°W several branches of the ESE Current extended southward reaching the Equator between 41°W and 38°W.

Another eastward flow, initially quite distinct from the ESE Current, entered the region of observation near 10°N, 45°W. This flow, called here the Equatorial Counter-current, extended to the east-southeast, being joined between 46°W and 39°W by northward branches from the ESE Current. From 39°W to 35°W the current continued, being strong near 35°W in all three cruises.

Near 38°W, the Equatorial Undercurrent first appeared on the Equator at depths above 100 m. It was apparently formed there at the confluence of the ESE Current from the north and a retroverse branch of the Guiana Current from the south. There were some indications of a weak or intermittant eastward current on the Equator as far west as 41°W. Data from all cruises indicated a strong Undercurrent at 35°W. All cruises agreed also in showing the high salinity core south of the Equator near 35°W. The core appears to represent the major contribution of the Guiana Current to the Undercurrent. Salinity as high as that in the Undercurrent Core was not found in the Guiana Current west of 39°W. Geopotential anomalies also indicate a branching northward from the Guiana Current near 39°N.

No.10 Productivity of the Tropical Atlantic Ocean *

by

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and
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A review of the measurements of primary production by C^{14} uptake and oblique plankton tows indicate the two most extensive productivity studies in the Tropical Atlantic Ocean were made during the EQUALANT I (February-March) and EQUALANT II (July-August) expeditions. These studies covering two meteorological seasons, showed four distinct areas of biological enrichment in the equatorial Atlantic from 20°N to 20°S latitude.

Two of the enrichment areas are near shore features found along the coast from Senegal to Liberia, and from Gabon to the Congo. Both of these areas are associated with oceanographic thermal fronts that migrate north during July - August and south in February - March. The maximum enrichment along the coast between Senegal and Liberia occurs in February - March while the northern front is present. A period of secondary enrichment attributed primarily to coastal upwelling and shallowing of the thermocline is found in this area during July - August.

The maximum carbon fixation and zooplankton biomass occurs on the Gabon to Congo coast in July - August during the presence of the southern front. After the front moves south, a period of secondary enrichment, associated with coastal upwelling occurs during February - March.

The third region of high carbon fixation rates occurs along the coast of Ghana and Ivory Coast in July - August during the period of maximum seasonal upwelling. Perhaps the most interesting area of high carbon fixation and zooplankton abundance is the fourth area found in a belt along the equator which extends from the African to South American Coast. This area of high productivity is definitely seasonal in nature with the highest production during July - August, when a thermal anticline is found near the equator.

The results of these extensive studies along with other productivity papers covering more limited areas of the Tropical Atlantic Ocean are reviewed.

No.11 Wind-Driven Currents of the Tropical Zone and the General Ocean Circulation (Theory and Calculations)

by

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The general theoretical problem of stationary wind-generated currents in the homogeneous ocean is considered. Only vertical exchange of momentum is taken into account and the boundary condition of zero motion on bottom is introduced. When the integral stream function is substituted for the three components of current velocity the problem is reduced to an elliptical type equation which may be solved numerically. A solution of this problem is obtained for the particular case of a rectangular ocean limited by parallels of 60° north and south of the Equator. When the wind stress distribution similar to that observed over the real oceans is introduced into the problem its solution shows a number of characteristic streams similar to those observed in the real oceans and particularly the equatorial sub-surface undercurrent. The same problem can be generalized for the two-layer system, in which case the solution shows, for example, such a well-known phenomenon as the raising of the discontinuity layer to the surface along the Equator

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No.12 Distribution of Zooplankton and Biological Structure in the Tropical Atlantic *

by

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The planktonologists of the Institute of Biology of South Seas taking part in the EQUALANT program in co-operation with scientists of other Russian and foreign institutions investigated the equatorial zone of the Atlantic from 15° to 45°W meridian. The quantitative method of collection of plankton gave a possibility to get an idea on the peculiarities of distribution of zooplankton in relation to hydrological conditions.

The zooplankton content in the richest region in the eastern part of the Atlantic was on average 55 mg/m^3. In the western part of the region, influenced by shelf waters of South America, this figure was about 50 mg/m^3. In the central part of the tropical zone the biomass did not exceed 20 mg/m^3.

The faunistic examination of zooplankton revealed its uniformity in the explored region which depends on the intensive flow of superficial waters westward and the effect of the Lomonosov Current moving in the opposite direction.

After detailed analysis of zooplankton composition and data concerned with its feeding habits the ratio herbivores - carnivores in pelagic community was determined. In the upper layer 0-50 m the biomass of herbivores makes up to 50% of the whole biomass of zooplankton. At a depth of 200-500 m this index is about 30%. The calculation revealed a perfect balance of energy in the pelagic community in tropic waters and corroborated the suggestion that dispersed organic matter can be utilised by micro- and mesoplanktonic organisms.

No.13 On the Content of Seston and Microplankton in the Tropical Atlantic

by

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The results of the determinations of microbiomass and seston weights from EQUALANT I and II cruises are reported and discussed.

The average vertical distribution gives seston (particulate matter) values from 20 to 250 mg/m^3 and albumen equivalents from 2 to 28 mg/m^3. These amounts are considerably less than those observed in the northern part of the Atlantic Ocean on previous expeditions. A great variation has been observed, which could not always be explained by the general circulation. Accumulation at the surface was more obvious than concentrations of seston and microplankton near or in the discontinuity layer of density. A stimulating influence of the equatorial undercurrent could not be established. In most areas the standing stock of microplankton was found to be low when compared to the biomass of larger plankton organisms and productivity data.

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No.14 Planktonic Foraminifera as Indicator Organisms in the Eastern Atlantic Equatorial Current System

by

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Selected water masses within the eastern Atlantic Equatorial Current System have been characterized by their indigenous planktonic foraminiferal faunas. Physico-chemical measurements and analyses of quantitative, controlled-depth plankton samples collected in the equatorial areas of 17° and 8° West Longitude have been used to show that the Atlantic Equatorial Undercurrent may be delineated by the population characteristics of selected foraminiferal species, and also to define major environments within the study area to establish preferred biotopes for the extant foraminiferal species. The validity of the utilization of population parameters to discriminate portions of this current system is established. The occurrences of individual species are described, and their distribution and abundance within the study area documented. Time-study analyses have been used to investigate cyclic population phenomena and to determine ranges of preferred depth, temperature and salinity for all species occurring within this sampling.

No.15 Quantitative Distribution of Zooplankton in Surface Waters of the Gulf of Guinea during August and September, 1963

by

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Universität HAMBURG

During the cruise of R.V. GERONIMO in EQUALANT II of ICITA, a total of 41 plankton samples were taken with the high speed HAI plankton sampler on a cruise track between Accra (Rep. Ghana) and Pointe Noire (Rep. Congo Brazzaville) via St. Helena island. The wet volumes determined from the samples were related to the hydrographic situation and partly to the distribution of phosphate and microbiomass of the area investigated.

In coastal waters between Cape Lopez and Pointe Noire, hauls taken with the HAI yielded particularly rich plankton samples (average 35 cm^3 / 100 m^3 of filtered water) in an area of upwelling. Also within the central region of the outflow of the river Congo, as far as 300 miles off the Congo mouth, the plankton volumes averaged about 10 cm^3/ 100 m^3, twice as much as at neighbouring stations outside the region of nutrient rich Congo water.

In the open ocean, plankton volumes were consistently low (average only 4 cm^3/ 100 m^3), except for a zone of upwelling between latitude 1°N and 4°S, where in nutrient rich water a maximum volume of 11.8 cm^3/ 100 m^3 was observed.

The distribution of the major taxonomic groups of zooplankton is discussed, with special reference to the Euphausiacea.

No.16 The Sub-Surface Lomonosov Current

by

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The paper recapitulates the history of the discovery of the sub-surface Equatorial counter current in the Atlantic Ocean by the r/v MIKHAIL LOMONOSOV of the Ukrainian Academy of Sciences

and gives descriptive characteristics of this current as studied by the same research vessel during the EQUALANT expeditions. During the period from 1959-1964 a total of 60 buoy stations with current recording devices of Alexeev's type have been carried out. The major characteristics of the current named the Lomonosov Current are given and it is stated that the volume of water transported by this current is comparable to that transported by the major oceanic currents. The paper stresses the most striking feature of the Lomonosov Current, namely the salinity maximum associated with it. The author sees the origin of this salinity maximum in two areas in the Western Atlantic north and south of the Equator where water has high salinity because of the intensive evaporation. According to the measurements made the Lomonosov Current attains a maximum speed of 120 cm/sec.

No.17 The Fat Cycle in Sardinella aurita (Cuv. and Val.)

by

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This paper deals with an attempt to determine the fat content of fresh Sardinella aurita (C and V) by the Soxhlet extraction method. From the results, a fat-water curve is drawn. Simultaneously, a Sauter Inframatic Moisture Determination balance was used to extract the moisture from the macerated tissue of fresh fish drawn from the same samples as those for the Soxhlet extraction experiment.

The means of the percentages of the moisture calculated from the Soxhlet experiments are compared with those derived from the direct moisture determination by the statistical formula of the form:-

$$\frac{\bar{X}1 - \bar{X}2}{\sqrt{\frac{S1}{n1} + \frac{S2}{n2}}}$$

The difference between the means of the percentages is found not to be significant at the 5% level. This fact permits the fat/water curve to be used to interpolate for the fat when only the moisture percentage of sardines from the same population is known. From the Soxhlet experiments, the lowest percentage fat contents 0.35 (1965) and 1.65 (1966) were in July, and the highest percentage fat contents 5.65 (1965)..... was in September. This trend was repeated with the moisture determination experiments as well, though with slightly different values. There is then a slight decrease till January and February when an increase occurs followed by a decrease before the main peak of the year in September.

No.18 The Fishery for Yellowfin Tuna in the Southern Gulf of Guinea

Results of the 1965 Campaign

by

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As for the 1964 tuna campaign off Gabon and Congo, the "Centre ORSTOM de Pointe-Noire" analysed the activities of the tuna clippers during 1965 by investigating their landings in Pointe-Noire.

Analysis of the data confirms the results of the 1964 observations: the highest tuna concentrations occur in the areas showing important thermic gradients (frontal zones and thermoclines); the biggest catches were made in 24°C and 25°C waters.

As a complement to those investigations, measurements (fork length and weight) were made between July and November 1965, on 1,700 fishes.

In order to define the specially high tuna occurence around Anno-Bon Island, four tuna surveys were carried out in this area from June 1965 to March 1966.

No.19 Preliminary Results of Drift-Bottle Releases and Recoveries in the Western Tropical Atlantic

by

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In February-March 1963, 476 drift bottles were released off the northern and north eastern Brazilian coasts, during the EQUALANT operation for the ICITA program; 35 bottles were recovered so far.

Recoveries are classed in five groups according to area of recovery and different travelling velocities.

GROUP I - Trinidad Island - The bottles recovered showed velocity ranges from 20.8 to 87.6 nm/24 hs., with a mean value of 52.1 nm per day or 2.17 knots.

GROUP II - Lesser Antilles - The velocity of the recovered bottles ranged from 10.3 nm/24 hs., to 25.7 nm/24 hs. The mean value was about 17.55 nm/24 hs. or 0.73 knots.

GROUP III - This group includes bottles which apparently have followed the Caribbean and Florida Currents with velocities ranging from 4.14 nm/24 hs. to 20.0 nm/24 hs. with a mean value of 10.8 nm/24 hs. or 0.44 knots. About fifty percent of these bottles drifted to the Florida Area, while the others were recovered in different places of the Caribbean Sea.

GROUP IV - Northern Brazil - Bottles released in front of the mouth of Pará and Amazonas rivers. The bottles that drifted to Maranhão, from station no. 40, showed a velocity range from 0.66 nm/24 hs. (151 days at sea) to 10.0 nm/24 hs. The velocities of the bottles found at Amapá released at stations 18 and 20 showed the lowest values of all ranging from 0.29 nm/24 hs. (422 days at sea) to 5.4 nm/24 hs.

GROUP V - Northeastern Brazil - The bottles were released during the return cruise off the northeastern coast of Brazil. The velocity range of this group is from 7.6 nm per day to 11.0 nm per day, with a mean value of about 9.0 nm per day or 0.4 knots.

The results show that:

1. The recoveries of drift bottles from stations located as far as 300 nm off the northern coast of Brazil confirm the presence of a strong current in a north western direction. This current as well as that present along the eastern coast of Brazil, also confirmed by the bottles released off the coast of Maceió (10°04' S - 35°14'W) and recovered on the northeast coast, are believed to represent branches of the South Equatorial Current.

2. The bottles released about 140 nm in front of the mouth of the Amazonas river suggest a slow drift current along the coast of Amapá. Those released near the mouth of the Pará River, are the only ones which drifted southeastwards along the coast, they suggest a somewhat faster coastal current to Maranhao.

3. Several recoveries of bottles at Trinidad Island showed clearly the effect of the strong Guiana Current: its mean velocity in March and April was about 2.2 knots as evaluated by the travel velocity of the bottles. Very strong winds (storm) in the first days of March may be responsible for an apparent increase of velocity, to an estimated 3.6 knots.

4. The recoveries at the Lesser Antilles confirm the penetration of the South Equatorial Current through that area into the Caribbean Sea. The greater part of the bottles and the fastest reached that area in April. One of them drifted with a velocity of 25.6 nm per day or 1.1 knots.

5. After having drifted a probable route of more than 2600 nm one bottle reached Miami with an average speed of 20 nm per day or 0.83 knots. The mean velocity value for all bottles concerning the Caribbean and Florida area was 10.8 nm per day or 0.4 knots.

6. The region off the northern coast of Brazil, between about 05°N and 09°N and extending to the West up to 50°W, seems to have been during last February under the influence of an eastward component of the surface current; this fact would in part explain the complete lack of recovery of bottles out of 90 which were launched within this area. This influence seems to have been weaker during cruise B in late March. The bottle which was found after more than two years (786 days) in Texas had been released late February at a station just within the limits of the area mentioned above (station 7: 05°06'N - 44°51'W).

No.20 Species Assemblages of Tropical Demersal Fish *

by

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LA JOLLA

The species assemblages of demersal fish in the Gulf of Guinea are determined by past accidents of zoogeography and by the present physical and biological environment. In general, the tropical marine fauna of the Gulf is impoverished in the zoogeographical sense for reasons connected with relatively recent geographical history of the region. The lack of extensive coral areas and the relatively shallow depths to which the mixed layers of tropical surface water extends have not permitted the recent development of a varied fauna of demersal fish. The mixed layer is stable with regard to depth throughout the year except in a sector between the Ivory Coast and Togo, in which region a seasonal, wind-induced coastal upwelling occurs late in the rainy season, and also in the regions of Senegal and Congo which are oceanographically transitional to the conditions of Eastern Boundary Currents farther to the north and south. A further very important effect of the shallow mixed layer is that relatively cool sub-thermocline water is present right through the tropical region on the continental shelf at depths well within the lighted or twilight zone; the light and temperature conditions at between 60 and 100 meters are remarkably similar in the tropical region and at latitudes as high as those of south-western Europe. The substrata of the continental shelf are relatively simply distributed, with a line of mud very close inshore along almost the entire coast, further mud deposits off the mouths of all rivers and lagoons, and below the break in slope on the continental shelf; a linear system of fossil coral banks at or near the break in slope also occur the whole length of the coast. The effect of the Niger, Cameroon and Congo rivers is to make muddy deposits dominant over sand in the eastern Gulf, the reverse being true in the west. The benthic communities, unlike those of similar regions in the Indo-Pacific, contain no more species or individuals per unit area or per ecological unit than in Atlantic high latitude benthic communities, with which almost all those recognized in the Gulf of Guinea can be equated.

Prior to GTS there were approximately 12 surveys for demersal fish resources along the coastline between Mauretania and Angola of which the results have been reported in the scientific literature. From the earliest of these it was evident that even the impoverished Gulf of Guinea fauna contained a considerably higher number of useful species (at least in the local context) than did the demersal fauna of high latitudes. As exploration proceeded, it became evident that there was a measure of agreement as to the nature of the species assemblages of demersal fish to be found on the continental shelf and the upper parts of the slope, and that these assemblages were relatively uniform the whole length of the tropical coastline under similar ecological conditions; the terminology used in the description of these assemblages, however, was far from uniform, though little confusion appears to have resulted. Whatever terms were used, there was agreement as to the existence of a fauna of muddy deposits on the continental shelf at depths less than the thermocline, and which existed in estuaries in a modified form; of a fauna occurring on the deposits below the thermocline and extending down to the break of slope; and of a less well described fauna on shallow rocky, corally and sandy areas. A relatively few species cut across these groupings and were usually dismissed as eurybathic taxa.

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The GTS data provided the possibility of confirming these subjective analyses in a precise manner and with data that were comparable over a very wide region; the data on the distribution of the 200 most frequently occurring species has been analyzed by means of the computer program written by Fager for detection of recurrent species groups in such data. The results of this entirely objective analysis confirmed to a high degree the previous suppositions, and the assemblages outlined above were clearly demonstrated; also demonstrated, however, was the fact that each assemblage was less homogenous than had been supposed, and within each a number of sub-groups were identified by the computer, the reality of which was confirmed by the application to them of the environmental data from each station, which showed that each had differing ecological requirements.

An examination of the geographical ranges of the constituent species of each assemblage indicates that those whose bathymetric range is restricted to depths shallower than the thermocline do not extend to the north and south beyond the tropical region; on the other hand, the assemblage which is typical of the deeper parts of the shelf below the thermocline has many species and genera in common with the fauna typical of the continental shelves at similar, and shallower, depths in the regions of the sub-tropical Eastern Boundary Currents. This sub-tropical fauna, characterized by sparids and denticids, evidently exhibits tropical submergence through the cool yet lighted shelf water referred to in the first paragraph. The fauna of the upper continental slope is even more similar to the fauna of similar depths as far north as the continental slope off western Europe, and presumably comparably far to the south.

The Gulf of Guinea is now probably the tropical region most completely explored for demersal fish resources, and it has been interesting to compare the species assemblages identified there with those described in other tropical areas, or identifiable in unanalyzed published data. It has been surprisingly easy to find assemblages parallel to those of the Gulf of Guinea in all tropical seas: in particular, wherever there are muddy deposits in shallow warm tropical water an assemblage of sciaenids, polynemids, ariids, cynoglossids and cludeids occurs which is very similar in most areas to that occurring in similar situations in the Gulf of Guinea. In the northern Indian Ocean the resemblance is particularly striking, while in the western Atlantic the percentage of sciaenids in the fauna is unusually high, and in the western Pacific certain families, such as Leiognathidae, unimportant elsewhere, are an important constituent of the fauna. The Gulf of Guinea fauna of shallow rocky areas, dominated by the genera Lutjanus, Lethrinus, Balistes, and so on, is clearly a very impoverished representative of similar faunas that are highly developed in the Antilles and Caribbean, in the eastern and central Pacific, on the banks, and around the archipelagos, of the Indian Ocean, and on the north-eastern coast of Australia. The sub-tropical sparid, denticid, and triglid fauna of the eastern Atlantic, which has been demonstrated to pass through the tropical region of sub-thermocline depths, can be recognized again off the eastern United States, off southern Brazil and Argentina, in the East China Sea, on the sub-tropical coasts of Australia and New Zealand, and in the northern Indian Ocean. Thus the tropical demersal resources now appear to be as homogenous as they might have been expected to be from the known importance of the zoogeographical boundary which occurs at the latitudinal extremes of the tropical region, a boundary which for many marine groups has been shown to be the major zoogeographical transitional region in the oceans.

No.21 Chemical Aspects of the Waters off the Amazon and Pará River Mouths

by

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Investigations were carried out in the area roughly limited by 0° - 10° N and 42° - 52° W area working on board C.T. "Bertioga". The research was carried out for the EQUALANT Expedition in February-March 1963 for the fulfillment of the research program of the ICITA. This summary refers to the data obtained on dissolved oxygen and dissolved inorganic phosphorous.

The principal causes of salinity fluctuations in the area under study are probably due to the winds and influx of fresh water from the Amazon river system; the variations of the runoff is in turn caused by rains in the river basin. The annual variation of winds is the probable cause of horizontal and vertical distribution of salinity.

We may admit the 35% isohaline as the boundary of admixture of river waters with oceanic waters and this extends over the shelf towards NE as far as the 200 m isobath at a distance of 150 nm and there turns north-westwards parallel to the coast.

Dissolved oxygen values vary between 5.23 ml/l and 3.44 ml/l; values higher than 4.50 ml/l were found along isolines parallel to the coast with 15.34‰ salinity. Dissolved oxygen content decreases as river water mixes with oceanic water; figures for dissolved oxygen show the presence of a narrow band of supersaturated water with 110%, along the current running north westwardly along the coast.

Mean figure for inorganic phosphorous was found to be 0.40 u g.at.PO_4 - P/I and on the basis of the dissolved oxygen data one may presume that nutrients brought by river waters are readily used up as the water of different origins mix.

The above observations refer to the upper layer in February-March; at 30 m depth river waters are absent.

No.22 Eggs, Larvae and Post - Larvae of the Anchovy from the Gulf of Guinea, Anchoviella guineensis (Blache and Rossignol)

by

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The description and biometry are based on numerous eggs and larvae caught in the plankton of Ivory Coast waters. Moreover some rearing was made from fertilized eggs.

The egg of the anchovy is very easy to determine. It is elliptical with average axes of 1.15 mm x 0.56 mm. The yolk is segmented without an oil globule.

The newly hatched larva is about 2.5 mm long. It is characterized by the very elongated yolk sac and the position of the anus located at about 3/4 of the total length. In the course of rearing, the mass of the yolk was completely consumed 48 hours after hatching.

The morphology of the post-larvae changes rather quickly. The length of the head increases while the insertion of the caudal fin takes up a more anterior position, as do the dorsal and anal fins. The ventrals, however, occupy a fixed position from the time of appearance. Between 3 and 4 cm. total length these allometries cease: the form of the body and position of fins virtually does not change any more up to the adult form. The scales appear at the same time and there is a change in colouration. This length corresponds then to the metamorphosis.

To distinguish the anchovy larvae from those of clupeids and especially Sardinella spp., the best character is the position of the anus, which is situated further forward in each stage of the former species. As soon as the dorsal fin appears, the anus is found at the vertical through the end of the dorsal fin whereas it is much more posterior in Sardinella.

The very great abundance in the plankton of anchovy larvae allows us to assume that the stock of these fishes must be important in Ivory Coast waters.

No.23 Zooplankton Occurrence over the Shelf of Ghana

by

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The Fisheries Division Laboratory at Tema has been carrying out a program of plankton sampling in the coastal waters off Ghana. This was intended to determine the qualitative and quantitative variations of zooplankton to provide the basis for a better understanding of the distribution and migrations of Sardinella aurita, which feeds on plankton. The present report is a general account of the species composition and quantity of zooplankton collected during the

period January 1963 to September 1965 at seven stations of three oceanographic transects established off Ghana.

The positions of the transects and the time and frequency of sampling are given together with the operational difficulties involved.

The plankton net, method of operations and depth of hauls in the different oceanographic seasons are described.

Displacement volumes of plankton were measured and identification and counting of organisms carried out on standard subsamples. To enable direct comparisons of plankton volumes or numbers of organisms per unit volume of water to be made, these have been adjusted to values per standard haul through 30 m approximately equivalent to 6 m^3 of water filtered.

The mean displacement volumes and total numbers of organisms were higher in 1964 than in 1963 and 1965. These values do not differ much from one transect to the other. Maximum displacement volumes and numbers of zooplankton occurred in June to August, during upwelling. For the rest of the year when stable conditions prevailed displacement volumes were low with little fluctuations, though moderately high numbers of zooplankton occurred in November and December. Copepods were the most abundant group recorded in the samples.

Zooplankton occurrence was higher on the Ghana continental shelf in 1964 than in 1963 and 1965. Fluctuations were also seen in the quantity and composition of the zooplankton associated with the upwelling period. Average volumes and numbers of zooplankton in June were four times those in May. Reference is made to similar zooplankton results off Lagos, Nigeria in 1961 and 1962, volumes being greatest at times of oceanographic instability.

Only limited comparative work has been carried out on nutrient measurements and this showed that the colder upwelled water (July-September) was richer in phosphate than the surface waters at other times. The appearance of phosphate rich water was accompanied by an outburst of diatoms.

Present investigations showed that there was much colder water during the upwelling in 1964 than in 1963 and 1965, and that the period of upwelling was longer in 1964, (four months), than in 1963 and 1965 (three months). It is suggested that the greater extent of upwelling in 1964 was the important contributing factor for the higher occurrence of zooplankton in that year.

Maximum zooplankton occurrence during upwelling coincides with the main fishing season for sardines. Also, the higher zooplankton occurrence in 1964 was accompanied with higher sardine catches.

Between the years of investigation, the occurrence of copepod species, except Calanoides carinatus, did not seem to show any consistent pattern. C. carinatus, which is associated with conditions of upwelling along the West African seaboard and outer part of the shelf off Walvis Bay, was recorded in the surface waters only, and in high numbers, during the upwelling.

No.24 Age Determination and Growth of the Sardine (Sardinella aurita) by Scales in Ghana Waters

by

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Age determination by scales of Sardinella aurita was carried out on over 11,000 specimens belonging to 134 samples collected during 1962-1963 along the shelf of Ghana.

Apart from the true year rings, two types of false rings could have been distinguished: firstly, one easily detectable eccentric ring, and secondly, one false ring very much like the year ring, which could be distinguished by its position only. This last mentioned false ring can be developed either as an inner false ring near the centre of the scale, or as a secondary

ring attached close to the true year ring. With advanced age the secondary rings gradually disappear.

The first year ring is formed one year after hatching. The estimated mean maximum fork length was 29.08 cm.

According to the changes in the monthly distribution of the marginal increment one might conclude that:

(i) the ring formation period begins in June and mainly corresponds with spawning season;

(ii) during the period from July to December the growth of fish is rapid while from December to June the growth rate is slow.

Much information has been given as to the ring formation in connection with the scale marginal increment. No correlation has been found between the scale marginal increment and the fork length of the fish.

In comparison with the sardines from the other areas of the eastern Tropical Atlantic, the length-age ratio for Ghana shows the smallest values: L1 - 11.80; L2 - 15.44; L3 - 18.25; L4 - 20.55; L5 - 21.76 cm. No explanation could be found for this slow growth.

No.25 General Bionomics of the Sardine (Sardinella aurita)

in Ghanaian Waters

by

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SHIMONOSEKI

For the purpose of study of some bionomical problems of Sardinella aurita along the coast of Ghana, 134 samples were collected during 1962 and 1963. Special attention was given to the adolescent fish.

As no particular regional differences in size of young fish proved significant, the author concludes that the spawning must have taken place approximately simultaneously all along the coast. Hatching and growth of four different size broods have been proved. The early spawners were found from June to September 1962, while the late spawners spawned until March of the following year. As mature Sardinella had not been found onshore during 1962 and 1963 the author suggested that the spawners retreated offshore and stayed in rather deep water.

The homogeneity of the distribution of mean values of the vertebral number of adults suggests a vivid inshore-offshore movement and could not support a racial differentiation. However, the broods of the early and late spawners, respectively, show some differences in the distritubion of mean values of the vertebral number. This might be explained according to differences in the temperature during the spawning and their early life stages.

Tagging experiments were carried out during 1962 and 1963, and were partly successful. Slightly less than half of one per cent of fish were recovered. Two specimens were recovered after five months in the same area where they had been released.

No.26 Horizontal and Vertical Distribution of Planktonic Production in the Gulf of Guinea and Adjacent Areas During February to May 1964

by

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Photosynthesis, amount of chlorophyll, albumen, seston, detritus and inorganic phosphate were determined at 77 stations in the Gulf of Guinea, along the West African coast between Conakry and Lagos, and in the northwestern tropical Atlantic between Cape Roxo and the Sargasso Sea. Investigations took place from February to May 1964. Samples were taken daily from depths of 100%, 50%, 25%, 10% and 1% incident solar radiation at local noon.

With decreasing transparency of the water an increase in the assimilation rate, as well as of chlorophyll and albumen content was observed. The amount of detritus did not show an interdependence.

As a result of these findings four groups of stations were established with different meter depths at 1% incident radiation. For each group representative average values were calculated. Group 1 includes stations north west of Cape Sierra Leone and off the West African shelf between Conakry and Tema (1% incident radiation at 36.6 m, SECCHI-depth 12.2 m): Group 2 includes stations off Monrovia to Lagos (1% incident radiation at 57.8 m, SECCHI-depth 21.0 m); Group 3 includes stations in the Central Gulf of Guinea (1% incident radiation at 72.0 m, SECCHI-depth 26.5); and Group 4 includes stations between 19°N, 29°W and the Sargasso Sea (1% incident radiation at 107.0 m, SECCHI-depth 34.0 m). Corresponding to the different meter depths of 1% incident radiation, there are also differences in the meter depths of 50%, 25% and 10% incident radiation within the four groups.

The highest assimilation rate was observed in Group 1. The values decreased equally from group 1 to 4, each value being about half of the previous one. The optimal ecological light conditions were found in the layer of 25% incident radiation (Group 1, 37.8; Group 2, 14.3; Group 3, 6.9; Group 4, 2.9 C^{14} mg/m^3/day) and here photosynthesis was best. In the layer of 10% incident radiation photosynthesis appears to be higher only if at the same time there is a thermocline. Then photosynthesis is sometimes as high as at 25% incident radiation, and only seldom higher. At 100% and 50% incident radiation energy of light is too high and at 1% too low; in these three layers photosynthesis is strongly depressed, sometimes falling to nearly zero.

The amount of chlorophyll showed the same trend within the four groups as the assimilation rate. The method of determination was not very accurate. Therefore, only the high amount of chlorophyll in Group 1 allowed an analysis of vertical distribution. Here the highest amount was found at 10% incident radiation (1.47 mg/m^3). However, photosynthesis was high at 25% incident radiation, where the amount of chlorophyll was 1.12 mg/m^3.

The amounts of albumen were highest in Group 1 (32-36 mg/m^3), followed by Group 2 (22-26 mg/m^3). In Groups 3 and 4 they were equal (10-17 mg/m^3). There were no remarkable differences in the vertical distribution. Contrary to other productivity data in Group 4, the amount of albumen was relatively high. This may have been caused by the unusually high amount of detritus found here as a good substratum for bacterial growth. It is likely that this detritus was derived from fallout from the atmosphere.

The amount of phosphate showed a very typical distribution. Above the thermocline values were low; they increased, however, below the thermocline where dying phytoplankton is remineralised and the assimilation rate decreases.

The reasons for the differences in productivity in the investigated area are as follows: (i) low amount of nutrients due to lack of turbulence and divergence in the open ocean (area between West Africa and the Sargasso Sea, Central Gulf of Guinea); (ii) raising of nutrients by upwelling (west of Conakry to west of Dakar) and by coastal influence (shelf area between Conakry and Tema). The productivity data showed considerable fluctuations in the area between Cape Palmas and Cape Three Points (from near the coast to as far as 120 miles offshore). The reason for this is not clear; it is very likely that the hydrographic conditions in that area are

changing frequently.

By comparing the albumen and seston data within different areas of the ocean where such investigations already have been made, it is seen that in higher latitudes the amount of albumen is much higher than in the tropics. The amount of seston depends mainly on local conditions and is often determined by abiotic factors.

No.27 The Equatorial Undercurrent in the Atlantic Ocean *

by

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Observations during EQUALANT expeditions have shown that the Equatorial Undercurrent in the Atlantic Ocean can be followed from 38°W or 39°W all across the ocean into the Gulf of Guinea. Based on the results obtained by different investigators an attempt has been made to present a summary of this important branch of the equatorial current system. The physical-chemical structure of water masses in the equatorial region is discussed and compared with some features of the dynamical structure of the Undercurrent. Special consideration is given to the sources of high salinity water that characterizes the core of the Equatorial Undercurrent along a zonal distance of about 5000 km. There is evidence that the longitudinal extent of the Atlantic Equatorial Undercurrent varies with the season. In April 1964, the Undercurrent could be traced as far east as 6°E near the island of Sao Tomé. In the late summer, at the end of the SW monsoon period, the eastern part of the current is weaker and the current seems to terminate further westward, probably between 5°W and the Greenwich meridian. The beginning, or the source, of the Atlantic Equatorial Undercurrent is in the vicinity of 38°W at the confluence of two currents coming from the Northern and Southern Hemisphere, respectively. These conclusions are supported by the salinity distribution in the layer of maximum salinity at depths between about 60 and 100 meters.

No.28 Some Observations on Length and Sex Distribution and Catch Effort on Bonga, Ethmalosa fimbriata (Bowdich), at Beniboye (Mid-West Nigeria)

by

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Since December 1965 regular sampling and collection of catch effort statistics of the canoe gill net (ring nets) fisheries for bonga (Ethmalosa fimbriata) were carried out at Beniboye, Mid-West Nigeria. Mean length varied slightly from month to month between 23.62 cm and 24.61 cm for the males and 23.90 cm and 24.84 cm for the females. The sex ratio, male to female, varied between 1.27 and 2.64, the dominance of males being possibly, at least partly, an effect of mesh selection. The distribution of maturity stages indicates that the fishing is based on maturing fish, with increasing numbers of nearly ripe (stage V) bonga occuring in the samples from February onwards.

The main fishing during the period of observation took place from December to February and again in May and June when the estimated catch per unit effort was highest.

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* Review Paper

No.29

On the Catch Statistics of Sardinella in Ghana

by

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This paper is dealing only with the catch statistics during the "cold" season in July-October and the catch figures given refer mainly to Sardinella aurita.

The total catch by canoes and motor vessels during the season July-October in the years 1959-1965 have been estimated as follows:

CATCH IN TONS

YEAR	1959	1960	1961	1962	1963	1964	1965
CANOES	21741	15675	35083	13343	5496	23948	2350
MOTOR VESSELS	403	1436	1318	2110	1957	7183	2560

With the introduction of outboard motorson the canoes (1960-1961) the catch by canoes reached a peak in 1961 with more than 15,000 tons, but in 1965 the total catch by canoes fell to only 2,350 tons and this was the first year when more sardines were landed by motor vessels than by canoes. Since 1962, thereare no reports on catch by canoes without motor and it is supposed that these canoes no longer take part in the sardine fishery.

The reports on number of canoes and number of trips at the recording stations show that the fishing effort during the sardine season reached a maximum in 1961 when 1500 canoes with outboard motor and 2209 canoes without motor did nearly 100,000 trips during 15 weeks. In 1965, the total number of trips had decreased to only 7,000 trips by motor canoes only. Even in 1964, when the availability of sardines were considered to be high during a long period of upwelling, the motor canoes did on average less than one trip per week as compared with 2.2 trips per week in 1961. Thus, in spite of mechanisation of a large number of canoes the total fishing effort, recorded in number of trips as well as in number of canoes, has been considerably reduced.

The maximum average catch per canoe per season, 40 tons, was recorded at one of the stations (Winneba) in 1964, but at most of the recording stations the average catch per canoe per season shows a declining trend. This may partly be ascribed to the reduced number of trips. However, the catch per trip also shows a decline at many of the recording stations since 1961. One must expect that the catch per trip for the ali-canoes as for any pelagic fishery to a large extent depends on the skill of the fisherman. The declining trend in catch per trip is most pronounced at the recording stations near the new harbours for motor vessels. It seems likely, therefore, that the best skilled fishermen are leaving the canoes in preference for motor vessels.

A comparison between the catch per trip of motor canoes and canoes without motor is only possiblefor 1961 when the former got an average catch per trip of 416 kg as compared with 293 kg for the latter. Thus, the introduction of outboard motors may possibly increase the catch per trip, but since the motors require more time for repairs the number of trips may be reduced with the result that total catch per canoe per season is less than before.

The yearly variation in total catch and catch per canoe per season as observed in the years covered by the present data are probably merely an effect of changes in time and extent of upwelling than in changes in stock abundance. However, with the quickly expanding fleet of motor vessels using ring nets it should be possible in a few years time to get better data for an evaluation of the sardine resources off the coast of Ghana.

No.30 The Distribution of Water Type Structure in the First 300 feet for Selected Areas of the Equatorial Atlantic

by

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This study was performed in an attempt to determine the relationship between the mean direction and velocity of the surface equatorial currents and their corresponding thermal structures within the first 300 feet. To establish this relationship, historical bathythermograph and hydrographic data from the archive files of the National Oceanographic Data Center were used.

The results of the analysis of the summer season (July-September) historical currents for the Equatorial Atlantic are noteworthy. The South Equatorial Current and the Equatorial Countercurrent in the near surface layers appear to be well defined. An anticyclonic current shift between these currents shows significant variations of vertical temperature structures along this shift zone. Vertical temperature decreases in the first 200 feet of the South Equatorial Current in the central and eastern Equatorial Atlantic are relatively small compared to the large vertical temperature decreases of the Equatorial Countercurrent.

The analyses of the mixed layer depth, vertical temperature gradient profile, and resultant currents are also presented.

No.31 Primary Production and Distribution of Phytoplankton in the Tropical Atlantic after Data obtained by the r/v LOMONOSOV

by

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The work is based on the three cruises of the r/v LOMONOSOV in March-May, September-October 1963 and in May-July 1964. Primary production has been measured by radiocarbon method following Sorokin's scheme. In addition the scheme suggested by the International Coordinating Group was employed during two cruises. Qualitative composition of phytoplankton was studied on the basis of net and Nansen bottle samplings from standard depths between 0 and 500 m. Analysis of the obtained figures of primary production shows differences both in geographical distribution and seasonal values. Also, the data differed from one year to another. Considerable differences were discovered in geographical distribution of phytoplankton biomass. In the areas of the greatest concentration of phytoplankton (Canary Current, upwelling areas along the African shelf, coastal areas of South America influenced by the Amazon discharge) the dominating species were diatoms.

No.32 The Pointe-Noire Trawl Fisheries

by

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The exploitation of the trawling grounds off Pointe-Noire began in 1961. At that time the trawlers worked on a practically virgin stock and it appeared interesting to follow its evolution. This paper deals with the landing statistics of the main Pointe-Noire trawling fleet. Fishing effort, influence of hydrographic seasons on fishing and the annual yield variations were studied.

The yield fluctuations analysis allows one to assume that the biomass of benthic fishes is not very important and that an increasing fishing effort would cause an appreciable decrease in the yield.

No.33 Distribution of Oceanographic Characteristics in the Equatorial Atlantic

by

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The authors describe maps of horizontal and vertical distribution of water temperature, salinity and density in the equatorial zone of the Atlantic Ocean. The analysis of the heat balance of the equatorial zone is also described and evaluation is given of the heat flow through the discontinuity layer. The equation of the thermal state of the upper layer was formulated for the purpose of this evaluation and as a result areas of upwelling and sinking of water in the equatorial Atlantic were defined.

No.34 Tunas of the Tropical Atlantic Ocean (Distribution and Abundance) *

by

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Four species are considered:

Thunnus thynnus
Thunnus (Germo) alalunga
Thunnus (Neothunnus) albacora
Thunnus (Parathunnus) obesus

The Tropical Atlantic Ocean is considered as that fraction of the Atlantic between the limits of maximum extension of the 20°C isotherm (surface), i.e. in the northa line joining Cape Cod (USA) to Cape Saint Vincent (Spain), in the south a line drawn from Mar del Plata (Argentina) to the high seas off South Africa.

The knowledge obtained on distribution and abundance of tunas in this region of the world is due more to analysis of the data supplied by commercial fisheries than to examination of the observations made by oceanographic surveys.

The four species have been noted:

A. At depth (infrathermoclinal distribution) in almost the whole of the zone under consideration;

B. At the surface (suprathermoclinal distribution)

1. for Thunnus thynnus at the four corners of this zone (NE, NW, SE, SW), with heavier concentrations in the Northern hemisphere than in the Southern one.

2.for Germo alalunga, except for a few cases, outside this zone and almost exclusively (from the fisherman's point of view) in the North-eastern Atlantic.

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* Review Paper

3. for Neothunnus albacora and Parathunnus obesus between the geographical tropics, with a predilection for the waters over the break of the continental shelf. At a first glance the African coasts would appear richer than the American ones: the occurrence of P. obesus at the surface is rarer. more irregular and localized than that of N. albacora; they occur more readily at the limits of the distribution area.

N. albacora and P. obesus are the only species which seem able to cross in situ the thermocline.

In general, the range of size is larger for surface tunas than for those living at depth. The small individuals are always absent from the latter habitat; (actual absence or selection due to the fishing methods?). The division is particularly clear for G. alalunga - individuals of less than one metre are never caught by floating long lines and very rarely of over one metre when fished by trolling, purse seine or with live bait.

If the rough charts of distribution reflect the location of the fishing boats as well as of fish schools and for this reason can be approximately superimposed, the introduction of the concept of density underlines notable differences in the respective distribution of the four species.

Density is given by the hooking rate, i.e. the amount of fish caught per 100 hooks laid (therefore this is valid for infrathermoclinal tunas, and is based on data extracted from Japanese statistics). This density is high when it reaches or surpasses one for T. thynnus and P. obesus and six for G. alalunga and N. albacora. The difference between these two figures gives a first indication of the relative numerical abundance of these four species.

High densities of T. thynnus are found off the Brazilian coast in a rectangle between the 12°N and 15°S parallels. Seasonal variations affect this distribution. The highest catch rates are found mainly south of the Equator during the first and second quarters, north of the Equator during the third and fourth quarter.

High densities of G. alalunga are found southwestward of a line drawn NW/SE from Cape Hatteras (USA) to Cape Frio, Angola. Seasonal variations affect this distribution. The highest catch rates are located mainly in the central and southwestern Atlantic (Brazil) during the first, second and fourth quarters, in the northwestern Atlantic (Antilles - Bahamas) and southwestern Atlantic (Angola) during the third quarter.

High densities of N. albacora are found in a slightly slanting band on the Equator, limited by two lines, one from Florida to Cape Verde (Senegal) and the other from Cape St. Roque (Brazil) to Cape Frio (Angola). Seasonal variations affect this distribution. The highest catch rates are located mainly in the Gulf of Guinea (sensu lato) during the first quarter, in the whole inter-tropical zone during the second, north of the Equator during the third and are fairly widely spread during the fourth quarter.

High densities of P. obesus are found off the African coast in the north in a flattened trapezium which starts from between Guinea and Mauritania and is directed westwards, narrowing and ending in front of the mouth of the Amazon, and in the south in an irregular square near the coast of Angola.

Seasonal variations affect this distribution. The highest catch rates are located in the south Atlantic during the first quarter, in the north Atlantic during the second, and each side of the Equator during the third and fourth quarters.

To summarize, the distribution of the infrathermoclinal populations of the above four species is roughly:-

- Brazilian for T. thynnus

- SW Atlantic for G. alalunga

- Intertropical for N. albacora, with a Guinean core and a West Indies core

- African for P. obesus, with Senegalese and Angolan core.

One can notice that for both species with a South American infrathermoclinical tendency, surface appearances are mainly in the Euro-African region.

If one glances at the problem of the relations of tunas to their environment one can see in N. albacora a species showing a tropism towards the great Equatorial currents, and in P. obesus a species split into two populations related to north and south Atlantic water masses. But a more detailed comparison of the physical oceanographic data and related distributions of the high density zones shows that for the time being it is difficult to establish a clear liaison between any of the known distributions and the hydrobiological structure of the Atlantic.

In surface waters where the role of the thermal fronts seems definitely admitted, one still finds imprecisions and contradictions on the optimum temperatures for concentration and the designation of the fertile side, this appearing to be the warm side in the case of fronts located in cold waters (20-24°C - these are then the thermal fronts) and on the cold side in the case of fronts located in warm waters (26-30°C - these are then generally fronts of a different type: salinity, turbidity, etc).

As for other pelagic fish, the catches of tunas may vary and in general they do so from one year to another. One can accept the following averages for the last five years for the tropical Atlantic, as defined previously (i.e. including among others the whole of the Iberian-Moroccan Bay):-

T. thynnus - 15 to 20,000 tons, half from deep water;

G. alalunga - 30 to 40,000 tons, the whole from deep water;

N. albacora - 70 to 80,000 tons, half from deep water;

P. obesus - 20 - 25,000 tons, 75-80 per cent from deep water;

Total: - 135 to 165,000 tons, about two-thirds from deep water.

No.35 Exploratory Prawn Trawling in the Waters off the Niger Delta

by

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and

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The presence of numerous river mouths on the coastline of Nigeria is associated with an extensive mangrove and lagoon system and soft muddy deposits in the shallow coastal waters. These typical deltaic conditions are associated elsewhere, as in the Gulf of Mexico and Bay of Bengal, with economically valuable prawn stocks. A prawn, tentatively identified as Penaeus duorarum Burkenroad, the pink shrimp, makes up a small but consistent proportion of the fish trawl catch of commercial and research vessels operating in Nigerian waters.

In January 1965, an exploratory prawn trawling survey was initiated by the F.R.V. "KIARA" of the Federal Fisheries Service and, since then, a series of exploratory cruises have been carried out in the delta waters using a 40 foot, no overhang, Gulf of Mexico shrimp trawl. A total of 119 hauls of one hour duration were made, covering both the wet and dry seasons. A report is also provided of the results of commercial exploratory fishing carried out in 1965 by two 70 foot American shrimpers with double rig 45 foot trawls.

The data presented shows that the prawn, Penaeus duorarum, occurs along most of the shelf between Benin River and Calabar; that is around the Delta and eastwards to the Cross River estuary. A total of seven areas is distinguished being made up of four rich areas alternating with three poorer areas. The catch-rate variation appears to be related to the nature of the bottom. A correlation is shown between mean catch rates and the particle size of the bottom deposits. In all areas the best catches are found between 15 and 50 metres in depth. A diurnal variation of catch rates is found which suggests that the period of maximal activity occurs during the hours of darkness, especially in the two hours before dawn and after dusk. In certain areas the data indicates a seasonal increase in the catch during the wet season, July until September, but elsewhere the evidence is conflicting.

The experimental catches have been sampled and carapace lengths have been measured. The size composition of the catch provides a high proportion, some 40%, of the large size catch categories utilized in commercial fisheries.

Prospects for a reasonable expansion of the fishery look promising.

No.36 Preliminary Investigations on the Biology of Brachydeuterus auritus (Val. 1831), in Nigerian Waters

by

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and

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Regular samples of Brachydeuterus have been obtained off Lagos and examined with a view to elucidating the life history of this very common fish species. Information is presented on the length distribution in these samples and also in the commercial trawler catches. Otoliths have been used for age determination although one of the major problems has been in ascertaining the number of rings laid down each year. Brachydeuterus appears to be a short-lived, early-maturing species with very few individuals having four or more opaque rings on the otoliths. Data on the sex, maturity and weight/length condition factors suggest two spawning peaks, one in December/January and the other in July. Some suggestions are made for future work.

No.37 On the Distribution and Abundance of Tuna Larvae

by

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Data collected during EQUALANT surveys I (January-March 1963) and II (July-September 1963) on the larvae of five species of tuna showed that the larvae of Thunnus albacares, T. obesus, Katsuwonus pelamis were widely distributed and abundant, whereas larvae of T. alalunga and T. thynnus were scarce. Temperature appeared to restrict the distribution of the species Thunnus (seldom collected below 26°C), but not Katsuwonus. Salinity appeared to affect the distribution of T. albacares (infrequently collected in salinites under 34 parts per thousand), but not of the other species. Each species of tuna larvae showed marked variation in sizes throughout time and space, and altogether they made up only a small portion (less than 1 per cent) of the total fish larvae collected. Comparisons of the distribution and abundance of larvae with the Japanese long-line catch statistics for 1963 gave little evidence in support of a correlation between them.

No.38 Some Features of Relationships between the Atlantic Equatorial Undercurrent and Its Associated Salinity Core

by

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During EQUALANT II the Research Vessel PILLSBURY of the University of Miami defined the fine structure relationship of the salinity-temperature fields of the Atlantic Equatorial Undercurrent and with drogue measurements determined that the equatorial salinity core was an indicator of the current. On EQUALANT III, in cooperation with the Research Vessel GERONIMO of the Bureau of Commercial Fisheries, this salinity core and current measurements were used to track the Undercurrent to within 60 miles of the Western Coast of Africa. One of the features of the temperature-salinity-current relationship of the Undercurrent observed during EQUALANT II and III is the North-South oscillation of the salinity core at 17° and 8°W. The importance of this oscillation became apparent during EQUALANT III when the Undercurrent turned southward at Sao Tomé Island (06°30'E, southern point at the Equator). There exists a possibility for the Undercurrent to flow either northward or southward at this location depending on its oscillation phase. Another feature was the uniformity within 10 to 15% of the velocities of the drogue measurements across the salinity core. These observations and the tracking of the salinity core for 1800 miles with a drop of only 0.03‰ in salinity led to the question of whether the salinity core mirrored the velocity core. During a cruise between PILLSBURY and GERONIMO in April and May of 1965, a detailed study of this North-South oscillation and the relative location of the maximum salinity and velocity cores was conducted at 8°W.

Over a 20-day period, five oceanographic sections were made by the PILLSBURY and the GERONIMO between 2°N and 2°S, and the PILLSBURY occupied a 12-day anchored station at the Equator. The oceanographic sections showed a southward oscillation of the salinity core with a period of at least 12-1/2 days and a latitudinal movement of at least 75 miles.

The *in situ* instrumentation allowed definition of the salinity-temperature-current relationships of the Undercurrent. The salinity core through most of its width is a very abrupt, single peaked structure with a vertical thickness of about 35 to 45 meters as defined by a 35.8‰ isohaline. At the outer limits of the salinity core, two or three salinity peaks with gradients of as much as 0.2‰ within three to six meters show the turbulent breakdown of the core.

On the anchored station, a vertical oscillation in the temperature and salinity distribution with a pronounced tidal oscillation of about 12-1/2 hours and several underfined short-term oscillations were observed. The average amplitude of the oscillation of the depth of the salinity core maximum is nine meters. At 450 meters, the average amplitude of the vertical oscillation is 40 meters.

The depth of the salinity core and current speed maxima have a similar tidal oscillation and over a 5-day period of observations, it was confirmed that the salinity maximum is below the velocity maximum with an average depth difference of nine meters.

Several unusual features, not noted before, were present in this cruise. One was the disappearance of a 36.2‰ water during the 20-day period which suggests that unlike other years different slugs of source water were moving into the eastern section of the Undercurrent. On the anchored station, there is a consistent feature in the temperature field of thermoclines of 1° and 1-1/2° gradients which oscillate between 200 and 240 meters and 400 to 440 meters respectively. The existence of these thermoclines at such depths and their relationship to the existing Atlantic Equatorial Current Systems is worthy of further study.

No.39 On Dynamics of Current in the Equatorial Atlantic *

by

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In 1959 a subsurface countercurrent was discovered by the "Mikhail Lomonosov" expedition in the equatorial zone of the Atlantic Ocean. Presidium of the Ukrainian Academy of Sciences named this current "the Lomonosov Current". The present paper is a brief discussion of the Lomonosov current. A detailed physical-geographical description of the Lomonosov Current is given in the works of A.G. Kolesnikov, V.F. Shapkina, G.P. Ponomarenko and N.K. Khanaichenko.

In addition, in research conducted by A.I. Felsenbaum and some other scientific workers of the Marine Hydrophysical Institute an attempt is made to build a theoretical model for the Lomonosov Current. Calculations performed on the basis of this model show satisfactory qualitative results. The main drawback of the model advanced by A.I. Felsenbaum is that baroclinity of fluid is neglected.

It should be noted that theoretical schemes developed by U. Charney, G. Stommel, A. Robinson K. Hidaka and other scientists and devoted to the Cromwell Current had been published before. These schemes permit to explain a number of features of the Cromwell Current but they also have considerable defects.

A new statement on the problem and preliminary calculations of the Lomonosov Current are proposed by the author in the present paper.

Baroclinity of fluid, effect of non-linear members, bottom topography and the change of coefficient of the vertical turbulent mixing with depth are taken into account in the given paper. A basically important role of the baroclinity of fluid is shown as well. Values of parameters at which the Lomonosov Current is obtained are noted and the analysis of cases when calculations lead to unreal results is given.

No.40 Deep Scattering Layers and Hydrographic Structures of Water Masses in the Gulf of Guinea

by

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From April to June 1964 a German oceanographic expedition of the Institute of Marine Research Warnemunde worked on board the R.V. "Professor Albrecht Penck" in the Gulf of Guinea. Simultaneously with the hydrographic and dynamic investigations, observations were made on the nature of the deep scattering layers in this area. By use of a 12 kc/s echo-sounder two principal deep scattering layers were recorded. One of these was generally found in a depth of 200 - 300 m., the other one in depths between 500 and 1500 m.

Net catches and other observations showed that the vertical migratory elements of the scattering layer consist of different groups of organisms such as large crustaceans, small bathypelagic fishes and squid. A comparison of the depth of the shallower deep scattering layer with the physical structure of the water masses in this area demonstrates that this

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scattering layer is situated in the range of a secondary discontinuity layer which is characterized by an increase of the gradients of temperature, salinity and density.

Turbidity measurements showed a distinct intensification of the turbidity in this zone which is undoubtedly due to the enrichment of suspended particles in this layer.

No.41 The Otolith as a Means for Differentiation between Species of Fish of very Similar Appearance

by

W. Schmidt
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The infraspecific variability in shape and morphological details of otoliths is small in contrast to the interspecific differences which are quite striking even when comparing closely related species of tropical fish which look very much the same in their general appearance (especially after the colours have gone due to fixation). Examples from seven families are given, in order to describe the main morphological characters of otoliths to be used in a determination of species which otherwise look very similar. The general shape of the otolith, as described by the ratio of length to breadth and thickness, as well as shape and extension of the sulcus and the pattern of the margin of the otolith are amongst the most conspicuous characters.

No.42 Causes and the Mechanism of the Lomonosov Current

by

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The author expresses the nature and the major features of the Lomonosov Current through applying a theoretical model formulated as a linear problem for both homogeneous and two-layer liquids. Solution of this problem is reduced to the integration of a two-demensional elliptical equation with a known value of the stream function on the contour of the basin. When existing distribution of wind stress is considered, the sub-surface countercurrent (Lomonosov Current) is one of the major features of the solution obtained.

No.43 Organic Carbon in the Waters of the Tropical Atlantic

by

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The author describes studies of organic carbon in the waters of the Tropical Atlantic. Determination of organic carbon was carried out by the method of dry burning of the residuals obtained by evaporation of sea water. The obtained figures of organic carbon content were close to those earlier obtained for the North Atlantic, the average of these figures being 1.54 mg. of carbon per litre. The extreme deviation of this figure do not exceed $\pm$ 30%. The amount of organic carbon decreases with depth. The results of these and other analyses led the author to determination of the annual biochemical consumption of oxygen.

No.44 Primary Production and Phytoplankton in Equatorial Waters - EQUALANT Program

by

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Oceanographic Institute, SÃO PAULO

During March 1963 primary production and phytoplankton standing stock were measured at six stations in a limited area in the equatorial western Atlantic Ocean. Production was measured with the C-14 technique according to Steemann Neilsen (1952); a gradual decrease in numbers of organisms per unit volume of water and decrease in production were observed with increasing distance from land, station 1 to station 6.

Primary production decreased from 0.864 to 0.014 g^C/m^2/day from coastal to open ocean stations. Maximum standing stock was found in the surface layer at st.1 with 583,000 cells/lt. and the minimum at 10 m depth at st.6 with 8,500 cells/lt.

At the time when the survey was made phytoplankton was more abundant in the surface layers of the euphotic zone at the stations nearer to land. A gradual change in abundance of the different components of the phytoplankton was noticed. Neritic species of diatoms were dominant coastalwards while coccoliths and oceanic diatoms dominated at oceanic stations.

The inshore stations showed strong admixture of Amazon River waters.

At station No. 3, distant 240 nautical miles from the coast values for primary production were intermediate (0.048 g^C/m^2/day). The distance from station 1 to station 6 corresponds to about 480 nautical miles.

No.45 Prawn Fishing in Nigerian Waters

by

D. Thomas
FAO/UNDP(SF) Fisheries Project, LAGOS

Prawn fishing in commercial quantities was not known in Nigeria prior to 1964. However, smaller quantities were occasionally landed by the expatriate trawl fleet, mainly during the rainy season. Trial of a Gulf of Mexico shrimp trawl and demonstration of its operation by the FAO Gear and Methods Expert of the UNSF/FAO Fisheries Project revealed the possibilities of commercial prawn fishing in Nigerian waters.

Trials with five different types of prawn trawls off Lagos during 1964-66 under UNSF/FAO Fisheries Project, from a small stern trawler of the Western Regional Fisheries Division, and with the collaboration of some of the commercial trawlers, gave interesting information about the efficiency of different types of shrimp trawls. Seasonal variation in the catch rates between the rainy season and the dry season were observed. Catch per hour during day and night fishing showed variation on the same grounds. Adjustments to the trawls and the use of tickler chains showed better catch rates of prawns.

Most of our trials were limited to a maximum of 23 fathoms depth and data from commercial trawlers indicated that better grounds for prawns were found towards the delta area.

Since 1964, a steady growth in the prawn fishing industry has occurred, and more investments for commercial prawn fishing are likely to come.

No.46 Some Observations on the Catch Composition when Fishing with Different Types of Trawls off Lagos

by

D. Thomas
FAO/UNDP(SF) Fisheries Project, LAGOS

Since 1963, experimental fishing with the 43 foot stern trawler "Akin Deko" has been conducted, the main fishing run being within the 25 fathom line off Lagos. The catch rate of croaker and other fish to prawns seems to vary according to the type of trawl being used. Thus, the "Granton trawl" gave a different catch rate of croaker/prawns than the "Vinge trawl", and the "Flat trawls" observed a much higher catch rate of prawns than the other when tried in the same area and season. This emphasises the need of using a variety of gears for exploratory fishing in order to assess the potentials of an area.

No.47 Observations on the Biology and Dynamics of Pseudotolithus senegalensis C.V. in the Region of Pointe-Noire (Republic of the Congo)

by

J.P. Troadec
Centre de Recherches Oceanographiques, ABIDJAN

During 1964 and 1965 trawl hauls were made regularly off Pointe-Noire down to the following depths: 15, 30, 40, 50, 70, 100 and 200 meters. On the basis of the landings of Pseudotolithus senegalensis and laboratory research, we have drawn conclusions regarding the ecology of this species and attempted the first rough studies of parameters relating to its dynamics.

It appears that fish of this species are relatively indifferent to changes in environmental conditions. Still a clear picture of the bathymetric distribution appears from a study of age or size classes: the breeding stock which lives in relatively deep water during the cold season moves into shallow water during the warm season at spawning time - which occurs twice a year during the two warm seasons along the coast in shallow areas, probably at river mouths.

Dynamic studies were concentrated primarily on growth and mortality figures.

Growth is rapid at first and then slows down during the fourth year. The diminution in the rate of growth occurs later among the females than among the males, producing a separation in the growth curves by sex starting from the critical age.

With the help of the length/weight ratio one can deduce gains in length from gains in weight. As regards body condition, there is a seasonal cycle paralleling hydrological conditions. This can be related to a spawning cycle and a feeding cycle.

No attempt is made to determine total number of deaths nor mortality rate as it is extremely difficult to establish an accurate age pyramid for the fish population. The annual survival fraction must be between 30 and 35 percent.

No.48 Some Problems of the Theory of Wind-Driven and Thermohaline Currents in the Equatorial Atlantic

by.

D.U. Vapnyar
Ukrainian Academy of Sciences, SEVASTOPOL

The system of equations comprising a system of linearized equations of motion, equation of continuity and equation of the density diffusion as well as the equation of hydrostatics is being reduced to a two-dimensional hyperbolical type equation for Fourier coefficients of current velocity. A particular case is then solved for a hypothetical equatorial channel with a given distribution of wind stress and density on the surface and a zero vertical gradient of density at the depth of no motion. Stream functions are obtained. The analysis shows that the calculated distribution of current velocities shows such prominent features as the Lomonosov undercurrent with maximum velocity at a depth of the order of 100–150 m.

No.49 Salinity - Temperature - and Velocity Profiles in the Gulf of Guinea Equatorial Waters

by

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From April to June 1964 five meridional sections (12°W, 8°W, 4°W, 0°, 4°30'E) between the African coast and 3°S were obtained in the "PENCK" - expedition sponsored by the German Academy of Sciences at Berlin.

Simultaneously with hydrobiological investigations narrow spaced current shear observations and records of a S-T-D-instrument give more details about physical-dynamical state of the oceanic troposphere. Besides varying positions of the equatorial undercurrent core with respect to the equator, isotachs drawn upon our measurements seem to form a core on each hemisphere sometimes. A distinct deplacement of the undercurrent core to the south of the equator together with a decrease in velocity was observed in the eastern part of the Gulf of Guinea. Records of our S-T-D-instrument showed a diminishing vertical extent of high saline water from west to east and a pronounced occurrence of the salinity maximum above the horizon with the maximum velocity. Observational data of 15 stations within the undercurrent core region demonstrate difficulties in identifying the undercurrent pattern by salinity profiles only especially in the region eastward of the Greenwich meridian. The S-T-D-instrument records in the undercurrent core distinct showed a very homogeneous layer beneath the axis of the undercurrent (in 50 - 80 m depth) and the 240 m (12°W) or 180 m (4°30'E) horizon where a clear decline in temperature and salinity seems to characterize the downward limit of the undercurrent core.

No.50 The Pelagic Mid-Water Fauna of the Eastern Tropical Atlantic with Special Reference to the Gulf of Guinea *

by

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Thirty five trawl hauls were made aboard the R/V JOHN ELLIOTT PILLSBURY in the Gulf of Guinea using the 10 foot model of the Isaacs-Kidd Midwater trawl (IKMT). These hauls were taken between Cape Palmas and Annobon during the months of May and June in 1964 and 1965. In depth they were distributed between the surface and 3,000 meters. They were supplemented by numerous dipnet and night-light studies.

Three groups of animals are considered, all exceeding a length of 30 mm., the cephalopods, the decapod crustaceans and the fishes. Volumes were not taken due to the decomposition which takes place in the warm surface layers, but counts were made of all specimens. For the purpose of this study the Gulf waters were divided vertically into the following zones: I. 0-50 m (27°-20°C); II. 51-300 m (20°-10°C); III. 301-1000 m (10°-4°C); and IV. 1001-3000 m (<4°C).

The results of these investigations are tabulated to show the dominant organisms of each group according to their depth and temperature range. Genera and species obtained at higher levels are not included in the lists of organisms obtained from lower levels.

From these IKMT studies it is suggested that the meso- and bathypelagic faunae more closely approach the surface of the Gulf of Guinea than in any other area of the tropics so far investigated. The midwater fauna is also much richer in both species and numbers than have so far been reported from the Atlantic. About ten times the volume of animals are taken in the Guinean hauls than in comparable hauls from the western Atlantic. The specimens, especially fishes, are fatter and longer than usual, reflecting a much greater available food supply.

The midwater fauna here is so rich and approaches the surface so closely that it is suggested that it might form the basis of a fisheries based directly upon it. It should also suggest a large predatory surface fish population with little chance of depletion due to failure of the food supply.

No.51 A Maturity Key for Penaeus duorarum, Burkenhead 1939, in Nigerian Waters

by

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and

S. Lefevere
FAO/UNDP(SF) Fisheries Project, LAGOS

A study is made of the maturity stages of the prawn, Penaeus duorarum in the coastal Nigerian waters. The authors propose a dressing technique for the gonads of both sexes and submit a maturity key to be read conveniently with the naked eye.

Six different stages were established.

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No.52 Review of the Principal Results of the Guinean Trawling Survey *

by

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FAO, ROME

Background information is given on the aims, planning and execution of the Guinean Trawling Survey (GTS). The hydrographic regimes in the region surveyed are discussed in relation to the conditions actually encountered during the survey. The overall fish catch showed that one to nine species dominated the catch at any one time or place and formed from 45 - 98% of the catch by weight; the important species at each depth are listed. The highest catch rates for total or demersal fish were found in the areas with seasonal hydrographic instability. Bathymetric distribution of total or demersal fish catches showed, with a few exceptions, two distinct peaks of abundance, one above and one below the thermocline, and corresponding to known community structures. An attempt is made to estimate from GTS data the resources of that part of the West African continental shelf surveyed; the limitations of such methods are indicated. The estimates of population size are given as (1) "observed density" in kg/hectare and (2) standing crop in metric tons, by statistical areas for the 15-50 m. and 50-200 m. depth zones. Estimates show the Bissagos-Guinea Shelf has the greatest potential with well over half of the total regional standing crop of demersal fishes of one million metric tons. The final section of the report discusses aspects of, and the necessity for, utilization of the existing fish resources of the region.

No.53 The Japanese Atlantic Long Line Fishery, 1956-1963

by

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Bureau of Commercial Fisheries, MIAMI

and

Jean Claude LeGuen
Centre ORSTOM, POINTE-NOIRE

Detailed catch and effort statistics for this fishery were recently published for the years 1956-1963. The total catch in the eight years was almost 12 million fish; over 90% of the catch in numbers was made up of the three tunas, yellowfin, albacore and bigeye. The fishing effort rose from 130 thousand hooks in 1956 to over 54 million in 1962 and in 1963. The yellowfin, 65-80% of the total catch from 1956 through 1960, decreased in importance to less than 50% in 1962 and 1963. Albacore, 10% of the total for the first three years, increased to about 25% in 1959-1961 and to 40% in 1962-1963.

We devided the Atlantic into 10 areas and analysed the monthly catch for each of the principal species in each of these areas. Decline in apparent abundance was observed for yellowfin in nearly all of the areas; it is shown that this decline is associated with the fishing effort of the long line fleet. The albacore, however, shows a decline in apparent abundance in only three areas; in two of these the decline is moderate. The bigeye has undergone little or no decline. Evidence is presented for migrations of these fish associated with changing oceanographic conditions.

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* Review Paper

No.54 Sardines and Related Species in the Eastern Tropical Atlantic *

by

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FAO/UNDP(SF) Fishery Research Unit, ACCRA

A short review on the life history of Sardinella and related species of the Gulf of Guinea is given with emphasis on the three main species, i.e. Sardinella aurita, S. eba, and Ethmalosa fimbriata. Special attention is paid to the information gathered on these species after the World Scientific Meeting on the Biology of Sardines and related Species, Rome 1959. Essential problems on the biology of Sardinella and Ethmalosa are pointed out and more efficient cooperation for the standardization of fisheries biological working methods in the Gulf of Guinea is suggested and discussed.

No.55 Distribution of Eggs and Larvae of Sardinella and Anchoviella in the Waters of Ghana

by

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FAO/UNDP(SF) Fishery Research Unit, ACCRA

A general survey on the distribution and abundance of planktonic stages of Sardinella spp. and Anchoviella guineensis (Anchovy) was carried out on the shelf of Ghana in 1964 and 1965.

Approximately every 10 to 14 days one sampling was made between Tema and Accra. In addition, monthly sampling was taken on regular hydrographic transects off Adina and Tema, and occasionally along the Ghanaian shelf, particularly off Sennya Beraku and Takoradi.

Eggs and larvae were collected by hauling conical zooplankton nets of one half and of one meter in diameter. The tows were made obliquely from a depth of 20 m to the surface, and were of 10 to 20 minutes duration, depending on the time available. The eggs and larvae of Anchoviella were separated from those of Sardinella, while the latter ones were not separated into species.

Judging from the number of eggs and larvae taken off Tema-Wineba Region (the rest of the stations were less frequented and the data collected insufficient for any definite conclusion) considerable spawning of Sardinella must have occurred near the shelf slope mainly in water of upwelling temperatures, i.e. between July and October. However, some eggs and larvae were found in plankton all the year round. One thousand eggs or larvae per unit haul were not rare (unit haul = 10 minutes tow of Nansen net of 1 m diameter). Abundance was greater in the inshore waters off Tema, Accra and Wineba.

Anchoviella eggs and larvae occurred in the plankton approximately simultaneously with those of Sardinella spp. However, the main spawning time seems to be extended beyond the main upwelling period. Unit hauls gave up to 20,000 eggs. There was greater abundance in the offshore waters towards the border of the shelf.

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No.56

Productivity and Microbiomass in the Tropical Atlantic in Relation to the Hydrographical Conditions (with Emphasis on the Eastern Area) *

by

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The first synoptic surveys of the tropical Atlantic for production (C^{14} technique) and microbiomass (filtration method) were obtained by the International Cooperative Investigations of the Tropical Atlantic (ICITA) (EQUALANT I - III Feb. 1963 - May 1964) and the Guinean Trawling Survey (GTS I and II, Sept. 1963 - June 1964).

In this report, special emphasis has been placed on the results of northern cruise of GTS I which surveyed waters from the coast of Ghana to Cape Roxo and in which the author participated personally.

High production was indicated by high chlorophyll, seston and albumen values of the water and was always related to low surface temperatures (20 - 23°C) and low transparency of the water (<10 m). These conditions were found only in certain areas during GTS I: Coastal waters of Ghana, Ivory Coast (Sept. 1963) and Cape Roxo (Dec. 1963) and not at all during GTS II (Feb. - June 1964). In the Tropical Atlantic high production was related to zones of divergence and coastal upwelling.

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ANNEX 9

Statement by USSR Scientists on the

follow-up of ICITA and GTS

The representatives of the USSR note that international cooperation in accordance with the programs of ICITA and GTS was successful and gives an example of the benefits from such scientific cooperation and coordination of the research activities of many countries.

The scientific results of ICITA and GTS are, on the one hand, of great theoretical interest and, on the other, of great importance from the practical point of view, especially for the African countries.

In this connection the representatives of the USSR believe that further cooperative exploration of the Atlantic is desirable and the USSR is ready to take part in any such project by sending out a vessel equipped with scientific staff. Insofar as the research of the Tropical Atlantic during ICITA and GTS gave much material which needs to be studied and summarized and also that new questions connected with the structure and dynamics of the tropical zone have arisen therefrom, it is proposed that the study of the waters adjacent to this zone will be of great interest.

The program of these proposed works, which should be carried out under the guidance of the IOC, should be developed and discussed in advance by the National ICITA Coordinators or by a special Working Group created under the IOC.

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